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REAL TIME DATA REDUCTION CAPABILITIES AT THE
LANGLEY 7- BY 10-FOOT HIGH SPEED TUNNEL

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INTRODUCTION

The 7- by 10-foot high speed tunnel is equipped with a digital data acquisition, display, and control system operated by a dedicated on-site computer. The computer software consists of three main parts: the real time batch monitor operating system (RBM), the operating acquisition program (OAP), and the real time applications task (RTAT). Real time data reduction is accomplished by RTAT which runs as a task under OAP.

The 7- by 10-foot high speed tunnel performs a wide range of tests employing a variety of model installation methods. To support the reduction of static data from this facility, a generalized wind tunnel data reduction program had been developed for use on the Langley central computer complex. This program, which was developed over a number of years by a data reduction support contractor, contains the best algorithms available for wind tunnel data reduction. Since RTAT was subject to the same requirements for generality and flexibility as the central program, it was decided to derive RTAT from the central program instead of writing a complete new program for the on-site computer. Thus, RTAT is a generalized wind tunnel data reduction program which contains the best algorithms available. The user invokes those RTAT features necessary for a particular test through the input specifications. To fit into the available memory on the on-site computer, RTAT uses a more sophisticated data management scheme than the central program and therefore the input specifications are slightly different.

This report describes the capabilities of the current release of RTAT. It is designed as a user's guide, an operator's manual, and a reference manual. It is not a programmer's guide. Thus, it contains detailed descriptions of the input specifications, instructions for the console operator, and full descriptions of the algorithms but does not document the code itself. A detailed description of the complete hardware and software environment in which RTAT executes is beyond the scope of this report.

The purpose of this report is to assist personnel involved in the conduct of tests in the 7- by 10-foot high speed tunnel.

HARDWARE

The 7- by 10-foot high speed tunnel digital data acquisition, display, and control system presently consists of a Honeywell (Xerox) Sigma 3 computer with 49152 words of memory in the central processing unit, an external input/output processor, 4.5 megabytes of rapid access disk storage, two nine-track tape drives, a card reader, a line printer, a Tektronix 4014 graphics terminal and hardcopy unit, a data acquisiton unit, and a data link to the central computer complex.

The data acquisition unit presently supports 50 analog channels, 20 digital channels, and 8 tachometer channels associated with the tunnel and 50 analog channels and 10 digital channels associated with a static calibration area. A number of similar systems exist at other Langley research facilities.

SOFTWARE

The operating system used on the Sigma 3 is the Honeywell (Xerox) real time batch monitor (RBM) system. A detailed description of RBM is beyond the scope of this report.

The operating acquisition program (OAP) was obtained as part of a combined hardware/software procurement for a number of similar data acquisition systems. The OAP runs as a foreground resident program under RBM. A brief description of OAP operation and OAP input specifications is provided in APPENDIX A. RBM and OAP provide a fixed environment in which RTAT must execute.

RTAT was developed specifically for the 7- by 10-foot high speed tunnel. RTAT consists of a frame task and a cyclic task which are written in FORTRAN and are assembled as part of OAP.

The RTAT frame task performs a fast calculation of Mach number and dynamic pressure. These vlaues are displayed at the tunnel drive control operator's console and updated approximately ten times per second.

The RTAT cyclic task performs all of the data reduction computations. The results are displayed at the data acquisition operator's console and at the model attitude control operator's console and are updated approximately once per second.

The data base concept employed by RTAT is described in APPENDIX B which includes a glossary of standard variable names used by RTAT.

The general input card specifications for RTAT are described in APPENDIX C. The extra equation input card specifications are described separately in APPENDIX D. The input specifications for interactive calibration workup sessions are described in APPENDIX E.

Some sample RTAT input setup decks are presented in APPENDIX F.

A description of the computational algorithms is presented in APPENDIX G.

The RTAT operating procedures are discussed in APPENDIX H.

Some hints on performing a manual check of the computations executed by RTAT are given in APPENDIX I.

RTAT IDLE LOOP

The idle loop is the path followed by RTAT to update the real time displays between data points. Raw data are obtained from the latest frame sampled by the OAP. These data are fully processed exactly as it would be during normal execution with the following exceptions:

(a) all I/O operations to the card reader, line printer, graphics device, and tape drive are suppressed,

(b) wind-off zero and tare data are not saved as they would be for a data point, and

(c) unless specifically requested in the input specifications, second order balance interactions are omitted.

RTAT NORMAL EXECUTION LOOP

The normal execution loop is the path followed by RTAT in response to a discrete event. Raw data are obtained from the latest OAP averaged record buffer. The data are fully processed and appropriate I/O operations performed. The following sections will describe the normal execution loop, more or less following the functional layout in Figure 1.

RTAT SPECIAL FUNCTION EXECUTION

In addition to the routine execution performed within the idle loop and normal execution loop, RTAT may bypass those loops and execute a specific function in response to a user request. Some examples of specific functions are weight tare computations, calibration data acquisition, calibration data computations, and system calibrate computations.

RTAT PLANNED FUTURE EXPANSIONS

RTAT will support powered model testing using high pressure air to supply exit nozzles on the model. However, that portion of RTAT intended to support the complexities of static powered calibrations and the interactive workup of static powered calibration data has not been coded. RTAT will add the code to support these functions.

The hardware capabilities of the 7- by 10-foot high speed tunnel data acquisition system are being expanded or are proposed to be enhanced. The possible future expansions to RTAT to support these capabilities are:

(a) A data link between the Sigma 3 and the Langley Central Computer Complex is presently being installed which will permit the Sigma 3 to submit priority batch data reduction jobs to the central computer complex. RTAT will add to the special function execution capability to support this data link.

(b) The model attitude control system is being converted from manual operation to automated operation. RTAT will add to the normal execution loop capability to control the automatic operation.

(c) The mechanically multiplexed pressure transducers may be replaced with electronically multiplexed pressure transducers. When that occurs, OAP and RTAT will be updated appropriately.

(d) The entire Sigma 3 data system may be replaced with a current state of the art data system. Since RTAT is entirely written in FORTRAN, employs completely general algorithms, and has a relatively straightforward interface into the system dependent features of the Sigma 3 system, RTAT will be converted to the new data system. After conversion, certain aspects of RTAT may be revised to take advantage of additional capabilities in the new data system.

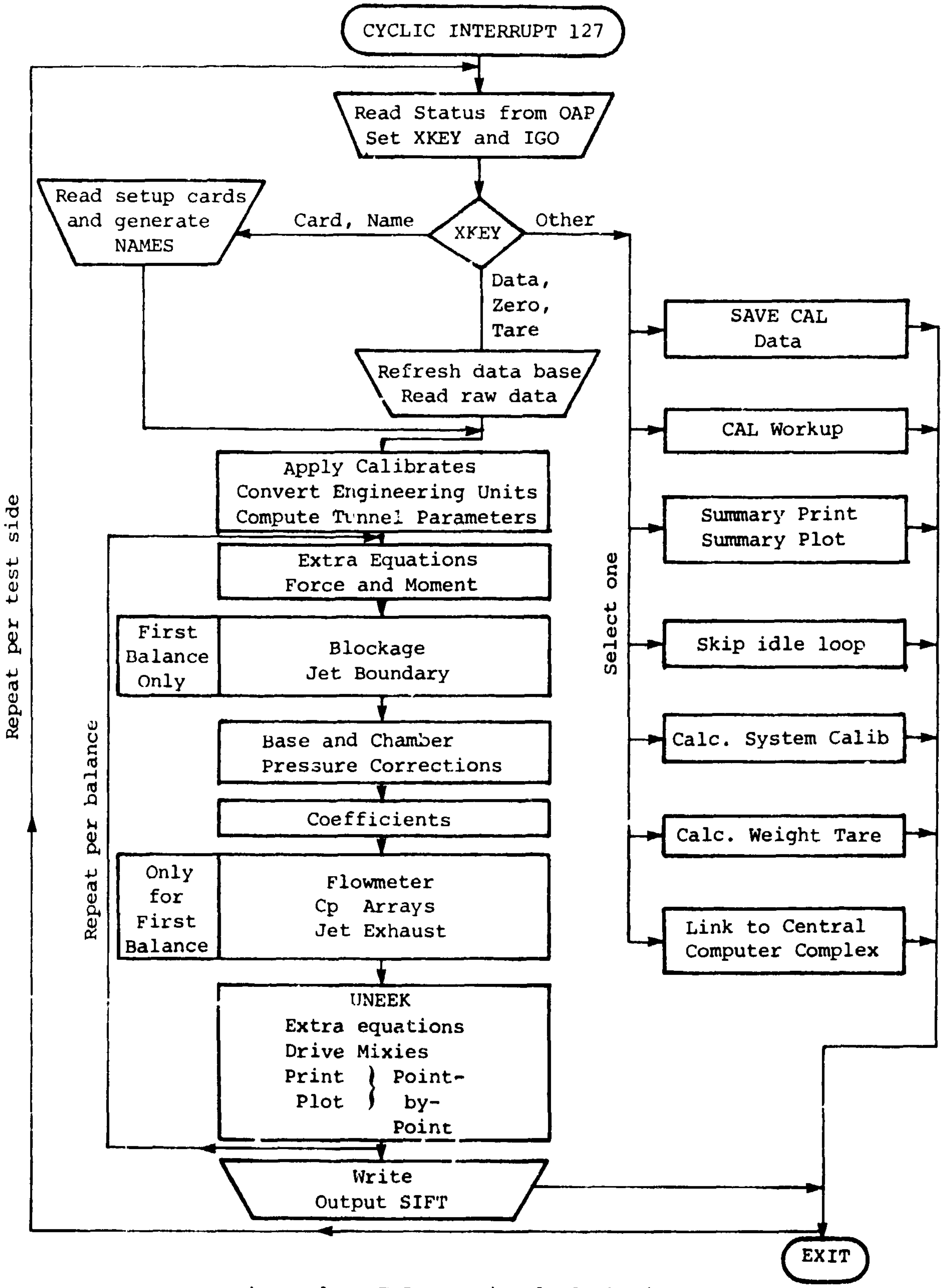

Figure 1.- RTAT Functional Block Diagram.

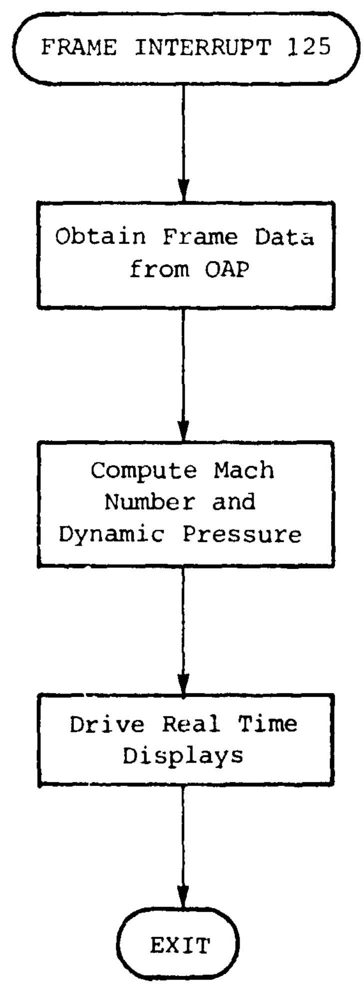

Figure 1.- Concluded.

APPENDIX A

AN OVERVIEW OF OAP

OAP operates the data acquisition unit hardware and directs the acquisition of the raw data. A frame of raw data consists of a single set of channel readings. Both OAP and RTAT use the frame data for idle (frame) loop computations. Upon the command to acquire a data test point, OAP will assemble frames of data and average them appropriately to form a data test point. The test point data are used by OAP and RTAT for normal execution (cyclic) loop computations which include the generation of output data.

OAP runs as a resident foreground program and consists of a number of tasks attached to different interrupt levels. OAP triggers the frame interrupt and the cyclic interrupt to which RTAT is attached. A task will begin executing each time the associated interrupt is triggered while the interrupt is armed and enabled. An interrupt is disabled while the associated task is executing and is enabled again when the task is completed.

OAP includes a permanently resident blank common area which is used for communication between tasks.

OAP Operation

Load an OAP setup deck into the card reader and start it up. When OAP begins execution, a message will be output on the teletype requesting that a System Control Panel ENTER be input. At this time, all control panels should be placed in the configuration needed for the test. For OAP to start, the System Control Panel must be setup with SELECT OPTIONS and REQUEST on. An attempt to start OAP without these selections will result in an error message output on the typewriter. At this point a System Control

Panel ENTER should be input. OAP will then read and process the OAP setup cards and any errors will be output on the line printer. OAP will read all of the control panels and perform a consistency check between the setup cards and the hardware configuration. If any discrepancies are detected, the errors will be output on the typewriter. Before proceeding further, it is necessary to clear all of these errors. This is accomplished by correcting the setup via cards or typewriter and/or changing the panel settings. Depressing a panel ENTER button will cause OAP to perform a new consistency check.

Analog System Calibration

There are two system calibration functions that can be performed by the operator:

1. Normal Calibrate
2. Hot Zero or Offset Calibration

A normal calibration is obtained by selecting CALIBRATE on the System Control Panel, setting the DATA IDENT thumbwheels to 00, and then depressing the System Control Panel ENTER button. The OAP will then calibrate all active analog channels and store the results on RAD file CALDATA as well as reporting the results on the line printer.

A hot zero or offset calibration is obtained in the same way as a normal calibration but with a DATA IDENT thumbwheel setting of 03. This calibration results in OAP storing an offset for each active channel which is subsequently applied to every frame of data. Obviously this is only valid if all analog channels contain differential transducers. Since the 7- by 10-foot high speed tunnel normally uses a number of absolute analog transducers, this type of calibration should not be used.

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If during the calibration, the operator should desire to cancel the calibration, this may be accomplished by depressing the RESET and ENTER buttons on the System Control Panel. This will cause OAP to abort the calibration.

Test Point Recording

To cause OAP to take a test point, the operator must select DAU DATA, set the DATA IDENT thumbwheel value to any value between 00 and 96, depress the ENTER button on the System Control Panel, and then depress the DAS READY/CYCLING button for each test point desired.

Test Point Intervention

If during the recording of a test point, the operator should desire to terminate the test point, this may be accomplished by depressing the DAS READY/CYCLING button again.

It is also possible to correct the OAP setup during a test point by the following steps:

(a) Depress the HOLD/CONTINUE button on the System Control Panel to place the system in HOLD.

(b) Correct the setup

(c) Depress the RESET and ENTER buttons on the System Control Panel

(d) Depress the HOLD/CONTINUE button on the System Control Panel to place the system in CONTINUE.

Selecting LIST on the System Control Panel will cause OAP output to go to either the line printer or the typewriter as specified in the OAP setup. Selecting TAPE on the System Control Panel will cause OAP to output data for a test point to the tape. Setting a channel number in a display thumbwheel and pressing the associated ENTER button will cause OAP to display the value associated with that channel.

OAP Input Card Specifications

The OAP setup cards follow a very restricted free format. The setup cards consist of a card type identifier in column 1 and one or more fields. The card type identifier and the fields must each be separated from the next by one or more blanks. More than one field is legal, but fields must be separated by one or more blanks. Column 72 must contain either a blank or a right parenthesis. Columns 73 through 80 may contain any information the user desires. Each field consists of two parts: the FIELD IDENTIFIER and the FIELD ARGUMENT. Multiple arguments are permitted within a single field, but the field must then be enclosed in parenthesis and the arguments separated by commas. Note that blanks may not be embedded in a field and that an argument may not end with a decimal point.

The control card type identifiers and the card description are given below:

Type	Description
I	INTERRUPT CONTROL
1	CHANNEL PARAMETER
2	DISPLAY SELECTION
3	CONTROL PARAMETER
5	DIGITAL CONSTANT SPECIFICATION
6	APPLICATION PROGRAM SPECIFICATION
9	INPUT DATA DELIMITER

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The only setup cards required by OAP are a type 1 card and a type 9 card. In the absence of any other card types or of any field, OAP will use the default specified in the description of the card.

A description of all card types is given below which employs the following conventions:

(1) a - represents an alphabetic character in a field entry

(2) m or n - represents a numeric digit in a field entry. The plus sign, minus sign, and decimal point are acceptable in a numeric field.

(3) x - represents any character in a field entry.

(4) The field arguments are represented at the maximum length appropriate to each parameter by the number of characters shown for each field argument. An actual argument may use fewer characters.

Setup Card Type I, Interrupt Control

This type can only be input by a card. The interrupt card contains two fields, the first gives the interrupt level name and the second gives the interrupt level to which that name is to be assigned. One and only one interrupt level is allowed per card.

The OAP interrupt defaults listed on the following page are usually sufficient.

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OAP Task Interrupt Assignments

NAME	LEVEL
DAICHN 0	110
DCOICH 1	111
	112 *
	113 *
CTL PNLS	114
CCU	115
DAUCTRLT	116
LAMPCTRL	117
DISPPNLT	118
DISPPCVT	119
MSTSDAIT	11A *
MSTSBKUP	11B
MSTSETUP	11C
ERRTRAPT	11D
OAPUNSTW	11E
OAPTWDTC	11F
SYSCTRLT	120
DTSTCTRL	121
MSTSDCOI	122 *
DIGCONS1	123 *
DIGCONS2	124 *
TS1FRAME	125
TS2FRAME	126 *
TS1CYCLT	127
TS2CYCLT	128 *
	129 *
	12A *
	12B *
	12C *
	12D *
OAP 07	12E
RBM HO	12F

Task Assignments Valid

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Setup Card Type 1, Channel Parameters

CHNO, nnn

This entry is mandatory as the first field on all type 1 cards. The channel numbers are assigned to the different channel types as follows:

Channel Numbers	Type
1 - 100	Analog Channels
151 - 190	Digital Channels
211 - 222	Tachometer Channels

Only one channel number may be specified per card.

NAME, xxxxxx

User may assign names to specific channels for use in printer and/or typewriter displays and in referring to the channel externally; however, only a total of 30 names are allowed.

DEFAULT OPTION: None

OFST, nnnnnn

This permits the user to override the calibration calculated offset. The value argument is given in millivolts, the allowable values ranging from a maximum of 65.535 to a minimum of -65.536. A decimal point is required.

DEFAULT OPTION: Calibration offset is used.

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UPLM, nnnnnn

Upper limit for alarm condition check. For analog channels, it is stated in millivolts, the legal values ranging from a maximum of 65.535 to a minimum of -65.536. For the digital channels and the tachometer channels, the value is stated in counts, the legal range being from zero to 99999. Only a total of 30 limits are allowed. A decimal point is required.

DEFAULT OPTION: No check is made.

LWLM, nnnnnn

Lower limit for alarm condition check. For analog channels, it is stated in millivolts, the legal values ranging from a maximum of 65.535 to a minimum of -65.536. For the digital channels and the tachometer channels, the value is stated in counts, the legal range being from zero to 99999. Only a total of 30 limits are allowed. A decimal point is required.

DEFAULT OPTION: No check is made.

DLTE, n

To delete limit checking set n = 1.

DEFAULT OPTION: Limits are checked.

SCRT, nnnnn

Scan rate for continuous scanning patterns. It is stated in SAMPLES/ SECOND, the range being from 1 to 20,000. Although this is not presently implemented, this field identifier is accepted by OAP and its presence is not considered an error.

DEFAULT OPTION: None.

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RNGE, xx

Specifies whether the ranging should be a set range or automatic. Valid parameters for this are A, 8, 16, 32 and 64. If A is specified, automatic ranging is used.

DEFAULT OPTION: .omatic rang. .g (A) is used.

PVID, x

Pressure valve indicator associat :s specific hardware with the channel. An entry of 0 (zero) causes the relate : channel to no longer be treated as a pressure valve channel. Up to 6 channels may be designated as pressure valve channels.

DEFAULT OPTION: 0 (zero), non pressure valve channel.

FSET, n

This is used to specify the desired setting of the filter associated with that analog channel. The valid parameters and the filters which they specify are:

n	filter
1	TYPE 1
2	TYPE 2
S	SPARE
W	WIDE BAND

It must be noted that the system wi : not proceed past the setup phase until all the hardware settings of the fil :rs are in agreement with the settings specified by the input parameters.

DEFAULT OPTION: W (WIDE BAND)

LCE (nnnnnnn, nnnnnnn)

Linear conversion coefficients. Two numeric arguments are required for this entry. Only one pair of linear coefficients may be specified per channel. Only 30 linear conversion coefficients are allowed.

DEFAULT OPTION: None

TSET, n

This is used to specify the time period in seconds setting for the tachometer channels. The valid parameters are:

n	period
1	0.1
2	1.0
3	10.0

DEFAULT OPTION: 1

Setup Card Type 2, Display Selections

LLIM, nnn

Listing limit for Type 2 calibration listing. Valid parameters range from 0.01 to 0.99.

DEFAULT OPTION: Type 1 calibration listing is used.

PLUS, nnn

Percentage of full scale to be used in the calibration routine for all four ranges. It is specified as a decimal number, the legitimate range being from 0.1 to 0.99.

DEFAULT OPTION: 0.90

SCOD, a

System configuration, channel data and calibration output destination. Either P (Printer) or T (Typewriter) may be designated.

DEFAULT OPTION: P (Printer)

Setup Card Type 3, Control Parameters

RTRY, nn

Number of retries to be attempted if parity error occurs in MSTS data transmission. From 1 through 99 may be specified. MSTS data transmission is not implemented.

DEFAULT OPTION: 7

AVG, nn

Length of averaging period, stated in seconds, if scheduled averaging is used. Valid parameters range from 1 to 65.

DEFAULT OPTION: None. Required input for scheduled averaging.

SCAN, nnn

Scan rate for discrete scanning pattern. Stated in frames/second, from 1 to 500 being acceptable. Entries evenly divisible into 2000 are recommended.

DEFAULT OPTION: 10 frames/second

PSSR, nnnnn

Pressure valve stepping rate. Stated in seconds, this is the time interval to be allowed for valve stepping and settling in programmed stepping rate. Valid entries are numbers from 0.2 through 100.0.

DEFAULT OPTION: None. Required input for programmed stepping rate.

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PVCY, nnn

This indicates the number of times to cycle through the scanivalves, recording one sample-per-port; nnn may be any integer from 0 through 533. An entry of zero (0) causes this to be treated as a null field and the operation becomes normal.

DEFAULT OPTION: 0 (zero)

TPSC, x

This entry causes each frame of data to be considered a test point. Any entry is legal, but an entry of zero (0) causes this to be treated as a null field and operation returns to normal.

DEFAULT OPTION: 0 (zero)

An (mm, nnnnnnn, ...)

This entry builds tables of angles for use by application programs; n in the name field identifies the table and must be from 1 to 6. The field arguments are in pairs, the first entry giving the position in the table, the second entry giving the value of the entry. Thus, (mm, nnnnnnn), where mm is any value from 1 through 32, and nnnnnnn is any floating point number up to 7 digits. This card allows storage of up to 6 tables with 32 floating point values each, for each test side.

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Setup Card Type 5, Digital Constant Specification

Type 5 cards assign named variables to specific thumbwheel switches on the digital constants panel. A maximum of 20 type 5 cards may be included in the setup deck

ILOC, xxxxxx

xxxxxx is the name given to the constant; i.e., the internal location of the constant.

CON (nn,nn)

The two field arguments specify the switch numbers of the first and last switches of a consecutive set of switches on the DIGITAL CONSTANTS PANEL whose settings will determine the value assigned to the constant. The value must be no less than 9 and no greater than 48, with the first value being less than or equal to the second value.

Setup Card Type 6, Application Program Specification

TIME, nnnn

nnn is any number from 0.01 through 100.0 and gives the cycle time interval in seconds for triggering of the cyclic application interrupt.

DATE, x

Deletes the cyclic program.

FRM, n

For n = 1, causes OAP to trigger frame tasks.

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Setup Card Type 9, Input Data Delimiter

END

This card notifies OAP that setup is complete.

Use of Typewriter for OAP Setup Input

With the exception of setup card Type I, all other legal setup entries may also be made by means of the console typewriter. Typewriter input is limited to 72 characters per line. In case of duplication of entries, the last entry is the one recognized by OAP.

Additional Considerations

The setup deck must be followed by a card, preferably one containing !EOD in columns 1 through 4, although this is not mandatory, even a blank card being acceptable to the card read routine.

Although OAP does check for certain logical inconsistencies, it accepts several versions of the same card, storing one set of values in over the other; the last value input being the one used. This allows typewriter input to override card input at any time.

One of the places where OAP does refuse to accept inconsistency is the FSET parameter. Until the filter settings on the channels correspond to the settings specified, the program will not proceed. Either the filters must be reset or the FSET cards must be changed (by typewriter input). Similar considerations apply to the TSET parameter.

As the setup cards are read, a listing will be printed of those cards containing errors. Cards which are correct will NOT be printed, but faulty ones will be shown with the errors flagged with dollar signs. The nature of the mistakes will be given on subsequent lines. Fault arguments will be ignored, but may be corrected through the typewriter input.

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When specifying arguments given in millivolts or counts, certain routines truncate and cause a loss of accuracy when numbers are converted to floating point. Therefore, numbers of small magnitude (e.g., 0.002) cannot be relied upon to act as triggers or limiting values.

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RTAT DATA BASE CONCEPT AND GLOSSARY OF NAMES

Since RTAT was derived from the central computer complex data reduction program, it is necessary to understand certain fundamental concepts which are employed in the central program.

The data reduction process is essentially a sequential computational process which may involve the use of a number of different programs. The standard interface file (SIF) concept was originally developed as a standard intermediate tape format to provide communication between diverse programs. On a SIF all records have the format:

```
XKEY,N,(DATA(I), I = 1,N)
```

where XKEY indicates the type of record. The initial record must be a name record; subsequent records may be any type including name records. For any non-name record type and for $1 \leq K \leq N$, the contents of DATA(K) will be the value associated with the name contained in DATA(K) in the most recently preceding name record. The SIF concept defined a sequential name oriented file structure providing variable length records having arbitrary internal organization. The SIF concept essentially defined an external data base which came to be viewed as a natural data base underlying the data reduction process.

As new programs such as the central data reduction program were written, they adopted the SIF concept as the internal data base driving the code. Each module would obtain its inputs from the data base and store its answers in the data base.

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RTAT uses the same basic SIF concept for both an external and internal data base. However, the limited memory available on the Sigma 3 dictated several modifications to the internal data base SIF concept described above. RTAT incorporates certain keywords as non-SIF constants in all record types in the internal data base. Instead of a static data base, RTAT employs a dynamic implementation of the data base in which the input specifications and the data base share the same area in memory.

RTAT maintains a copy of the input specifications on a disk file, maintains a names record on a disk file, and maintains a non-name or values record on a disk file. The first execution of RTAT for a new setup generates the names record and the access map. Each module searches the names record fot its inputs, maps their locations, and reserves locations in the data base for its answers. RTAT maintains the access map in a permanently resident COMMON area. On subsequent executions, modules use the map to access the values record. The input specifications, names record, and values record share a permanently resident COMMON data base area. At the start of each execution, RTAT copies the input specifications into the data base area and then appends the raw data obtained from OAP. RTAT then executes the computational algorithms. Since the input specifications are ordered in the sequence in which they are used, RTAT knows when it has finished using a block of input specifications. RTAT then collapses or shifts that block of input specifications out of the data base area thereby making space available for the results which are being appended to the data base. When RTAT completes executing the algorithms, all input specifications have been collapsed out of the data base area and only raw data and results remain in the data base which can then be written on a SIF answer tape. When the next execution of RTAT begins, RTAT refreshes the data base by copying the input specifications into the data base area and then entire process is repeated.

The following glossary defines all of the standard names used by RTAT.

Standard Name	Description
ABS	Extra equation type identifier
ACOS	Extra equation type identifier
AF	Uncorrected delta axial force component (Main Balance)
AF2	Uncorrected delta axial force component (Second Balance)
AFB	Axial force in pounds due to base pressures which is to be applied as a correction to balance loads
AFBA	Balance axis axial force component
AFC	Correct delta axial force component
AFCH	Axial force in pounds due to chamber pressures which is to be applied as a correction to balance loads
AFMA	Model axis axial force component
AFTA	Axial force weight tare component
AFTO	Correct total axial force component
AFWA	Wind axis axial force

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Standard Name	Description
ALPG	Gravity axis pitch angle in degrees
ALPI	Initial sting pitch deflection angle in degrees
ALPS	Sting pitch deflection angle in degrees due to load
ALPU	Input D-type constant giving the upflow angle in degrees as a pitch rotation from the wind axis to the gravity axis
ALPW	Angle of attack in degrees
ALPZ	Pitch attitude of the balance with respect to gravity when the wind-off zero is recorded, in degrees
ASIN	Extra equation type identifier
ASQn	Cross-sectional area of throat of Flowmeter n
ATAN	Extra equation type identifier
ATN2	Extra equation type identifier
B	Input I-type constant giving model reference span in inches
BALA	Input keyword. A balance name and calibration date immediately follow this keyword.
BETA	Angle of sideslip in degrees
BETn	Diameter ratio of throat to inlet of Flowmeter n
BLK	Input keyword controlling blockage and jet boundary correction
BTCH	Batch number
CA	Model axis axial force coefficient

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Standard Name	Description
CAI	Extra equation type identifier
CAB	Coefficient of axial force due to chamber pressures which contributed to AFB
CAC	Coefficient of axial force due to chamber pressures which contributed to AFCH
CAS	Extra equation type identifier
CBAR	Input D-type constant giving model reference chord in inches
CD	Stability axis drag coefficient
CDPR	Blockage drag factor
CDW	Wind axis drag coefficient
CL	Stability axis lift coefficient
CLC	Blockage lift factor
CLSQ	Stability axis lift coefficient squared
CLW	Wind axis lift coefficient
CM	Model axis pitching moment coefficient
CMS	Stability axis pitching moment coefficient
CMW	Wind axis pitching moment coefficient
CN	Model axis normal force coefficient
CNI	Extra equation type identifier
CONV	Input keyword. If nonzero, balance interaction iterations will be printed out.
COS	Extra equation type identifier
CP	Extra equation type identifier

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Standard Name	Description
CPBn	Pressure coefficient for base pressure n
CPCn	Pressure coefficient for chamber pressure n
CRM	Model axis rolling moment coefficient
CRMS	Stability axis rolling moment coefficient
CRMW	Wind axis rolling moment coefficient
CSS	Extra equation type identifier
CY	Model axis side force coefficient
CYM	Model axis yawing moment coefficient
CYMS	Stability axis yawing moment coefficient
CYMW	Wind axis yawing moment coefficient
CYS	Stability axis side force coefficient
CYW	Wind axis side force coefficient
D1n	Inlet diameter of Flowmeter n
D2n	Throat diameter of Flowmeter n
DCn	Discharge coefficient of Flowmeter n
DELA	Jet boundary angle of attack correction
DELM	Jet boundary pitching moment correction
DRAG	Stability axis drag
ELSE	Extra equation type identifier
ENDD	Input optional keyword following real time display specifications. If present, all constants preceding ENDD will be collapsed out of the data base.
ENDF	Input optional Keyword following the balance interaction deck. If present, all constants preceding ENDF will be collapsed out of the

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Standard Name	Description
ENDF (concluded)	data base, ENDF is required after each interaction deck if NBAL > 1.
ENDG	Input required Keyword following the summary print specifications. All constants preceding ENDG will be collapsed out of the data base.
ENDH	Input required Keyword following reorder hookup specifications. All constants preceding ENDH will be collapsed out of the data base.
ENDM	Input required keyword following special point-by-point plot specifications. All constants preceding ENDM will be collapsed out of the data base.
ENDP	Input required Keyword following the point-by-point print specifications. All constants preceding ENDP will be collapsed out of the data base.
ENDQ	Input optional Keyword following the engineering unit specifications. If present, all constants preceding ENDQ will be collapsed out of the data base.
ENDS	Input required Keyword following summary plot specifications. All constants preceding ENDS will be collapsed out of the data base.

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Standard Name	Description
ENDT	Input required Keyword following normal point-by-point plot specifications. All constants preceding ENDT will be collapsed out of the data base.
ENDU	Input required Keyword following the engineering unit extra equation specifications. All constants preceding ENDU will be collapsed out of the data base.
ENDX	Input required Keyword following the force extra equation specifications. All constants preceding ENDX will be collapsed out of the data base.
EXP	Extra equation type identifier
Fn	Velocity of approach factor of Flowmeter n
FDPn	Flowmeter differential pressure in psi of Flowmeter n
FPn	Flowmeter inlet static pressure in psi of Flowmeter n
FP2n	Throat static pressure of Flowmeter n
FTn	Flowmeter temperature in ^{O}R of Flowmeter n
GPn	Input Keyword associated with summary print specifications
HI	Indicated tunnel total pressure in PSF
ID	Data identification code number

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Standard Name	Description
IFEQ	Extra equation type identifier
IFGE	Extra equation type identifier
IFGT	Extra equation type identifier
IFLE	Extra equation type identifier
IFLT	Extra equation type identifier
IFNE	Extra equation type identifier
INTR	Input Keyword signifying that an I-card format balance interaction deck immediately follows
IORD	Input optional Keyword giving the order of interactions to be considered for the balance. If omitted, second order is assumed for data points and first order for the idle loop.
J2	Input D-type constant specifying angle of attack jet boundary correction factor
J3	Input D-type constant specifying pitching moment jet boundary correction factor
K	Total blockage correction factor
KB	Body blockage correction factor
KBI	Input D-type constant specifying body blockage correction factor
KDFL	Input D-type constant specifying the deflections are to be calculated on the basis of total loads or delta loads. If omitted, TOTAL is assumed.

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Standard Name	Description
KW	Wing blockage correction factor
KWI	Input D-type constant specifying wing blockage correction factor
KWK	Wake blockage correction factor
L/D	Stability axis lift to drag ratio
LAMn	Normalized pressure of Flowmeter n
LIFT	Stability axis lift
MACH	Free stream test section Mach number
MACH	Extra equation type identifier
MPR	Uncorrected Mach number
MPLT	Input Keyword giving the number of special point-by-point plot specifications which must immediately follow. The maximum is 4.
NBAL	Input Keyword giving the number of balances to be computed. The current maximum is 2.
NBAS	Input Keyword giving the number of base pressure coefficient specifications which must immediately follow
NBM	Input Keyword giving the number of rotation specifications from the balance axis to the model axis which must immediately follow. The maximum is 12.
NCBR	Input Keyword giving the number of chamber pressure coefficient specifications which must immediately follow.

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Standard Name	Description
NCP	Input Keyword giving the number of pressure coefficient array specifications which must immediately follow
NDSP	Input Keyword giving the number of real time display specifications which must immediately follow. The maximum is 100.
NEU	Input Keyword giving the number of engineering unit specificatins which must immediately follow
NEXF	Input Keyword giving the number of force extra equation specifications which much immediately follow
NEXU	Input Keyword giving the number of engineering unit extra equation specifications which must immediately follow
NF	Uncorrected delta normal force component (Main Balance)
NF2	Uncorrected delta normal force component (Second Balance)
NFB	Normal force in pounds due to base pressures which is to be applied as a correction to balance loads
NFBA	Balance axis normal force component
NFC	Correct delta normal force component

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Standard Name	Description
NFCH	Normal force in pounds due to chamber pressures which is to be applied as a correction to balance loads
NFDF	Input D-type constant giving normal force sting bending deflection constant in degrees/pound
NFLO	Input Keyword giving the number of flowmeter specifications which must immediately follow
NFMA	Model axis normal force component
NFTA	Normal force weight tare component
NFTO	Correct total normal force component
NFWA	Wind axis normal force
NGB	Input Keyword giving the number of rotation specifications from the gravity axis to the balance axis which must immediately follow. The maximum is 12.
NGP	Input Keyword giving the number of summary print specifications which must immediately follow. The maximum is 5.
NHVK	Input Keyword giving the number of reorder hookup specifications which must immediately follow
NOOP	Extra equation type identifier

Standard Name	Description
NPLT	Input Keyword giving the number of normal point-by-point plot specifications which must immediately follow. The maximum is 4.
NPG	Input Keyword giving the number of point-by-point print specifications which must immediately follow
NRTO	Input Keyword giving the number of pressure ratio specifications which must immediately follow
P1	Free stream test section static pressure in PSF
PGn	Input Keyword associated with print specifications
PHIG	Gravity axis roll angle in degrees
PHII	Initial sting roll deflection angle in degrees
PHIS	Sting roll deflection angle in degrees due to load
PHIW	Roll angle
PHIZ	Roll attitude of the balance with respect to gravity when the wind-off zero is recorded, in degrees
PI	Indicated tunnel static pressure in PSF
PIPR	Uncorrected static pressure
PM	Uncorrected delta pitching moment component (Main balance)

APPENDIX B

Standard Name	Description
PM2	Uncorrected delta pitching moment component (Second balance)
PMB	Pitching moment in inch pounds due to base pressures which is to be applied as a correction to balance loads
PMBA	Balance axis pitching moment component
PMC	Correct delta pitching moment component
PMCH	Pitching moment in inch pounds due to chamber pressures which is to be applied as a correction to balance loads
PMDF	Input D-type constant giving pitching moment sting bending deflection constant in degrees/inch-pound
PMMA	Model axis pitching moment component
PMSA	Stability axis pitching moment
PMTA	Pitching moment weight tare component
PMTO	Correct total pitching moment component
PMWA	Wind axis pitching moment
QINF	Free stream test section dynamic pressure in PSF
QPR	Uncorrected dynamic pressure
R11 R21 • • • R33	The nine elements (r_{ij}) of the balance attitude transformation matrix [R]

APPENDIX B

Standard Name	Description
REFL	Input D-type constant giving the length in feet for the calculation of Reynolds number. If omitted, the Reynolds number per foot is calculated.
REYN	Free stream Reynolds number in millions
RH	Free Stream relative humidity in percent
RHO	Free stream density in slugs/ft^3
RHO	Extra equation type identifier
RM	Uncorrected delta rolling moment component (Main balance)
RM2	Uncorrected delta rolling moment component (Second balance)
RMB	Rolling moment in inch pounds due to base pressures which is to be applied as a correction to balance loads
RMBA	Balance axis rolling moment component
RMC	Correct delta rolling moment component
RMCH	Rolling moment in inch pounds due to chamber pressures which is to be applied as a correction to balance loads
RMDF	Input D-type constant giving rolling moment sting bending deflection constant in degrees/inch-pound

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Standard Name	Description
RMMA	Model axis rolling moment component
RMSA	Stability axis rolling moment
RUN	Run number
S	Input D-type constant giving model reference area in square feet
SET	Extra equation type identifier
SETN	Extra equation type identifier
SF	Uncorrected delta side force component (Main balance)
SF2	Uncorrected delta side force component (Second balance)
SFB	Side force in pounds due to base pressures which is to be applied as a correction to balance loads
SFBA	Balance axis side force component
SFC	Correct delta side force component
SFCH	Side force in pounds due to chamber pressures which is to be applied as a correction to balance loads
SFDF	Input D-type constant giving side force sting bending deflection constant in degrees/pound
SFMn	Flowmeter supercompressibility factor of Flowmeter n

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Standard Name	Description
SFMA	Model axis side force component
SFSA	Stability axis side force
SFTA	Side force weight tare component
SFTO	Correct total side force component
SFWA	Wind axis side force
SIN	Extra equation type identifier
SOUT	Input Keyword specifying the start of output SIF data. The data base following SOUT will be retained during data base collapses.
SPRn	Static pressure ratio of Flowmeter n
SPLT	Input Keyword giving the number of summary plot specifications which must immediately follow. The maximum is 4.
SSC	Extra equation type identifier
SUMV	Extra equation type identifier
TAB1	Extra equation type identifier
TAB2	Extra equation type identifier
TAB3	Extra equation type identifier
TAB4	Extra equation type identifier
TAN	Extra equation type identifier
TCJ	Extra equation type identifier
TCK	Extra equation type identifier
TDEW	Indicated tunnel dewpoint temperature in ^{o}R

APPENDIX B

Standard Name	Description
TEST	Test number
TFn	Flowmeter temperature in ^{o}F of Flowmeter n
THEN	Extra equation type identifier
THTn	Normalized temperature of Flowmeter n
TINF	Free stream static temperature in ^{o}R
TT	Indicated tunnel total temperature in ^{o}R
V1	Axial force weight tare per unit weight
V2	Side force weight tare per unit weight
V3	Normal force weight tare per unit weight
VAAV	Extra equation type identifier
VAS	Extra equation type identifier
VASQ	Extra equation type identifier
VAV	Extra equation type identifier
VAVG	Extra equation type identifier
VDS	Extra equation type identifier
VDV	Extra equation type identifier
VEL	Extra equation type identifier
VINF	Free stream test section velocity in ft/sec
VISC	Free stream test section absolute viscosity in slugs/ft-sec
VMS	Extra equation type identifier
VMMV	Extra equation type identifier
VMV	Extra equation type identifier
VPR	Uncorrected velocity

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Standard Name	Description
VSS	Extra equation type identifier
VSSQ	Extra equation type identifier
VSV	Extra equation type identifier
WAF	Input D-type constant giving model weight tare in pounds for balance axial beam. A card input overrides the value calculated from a tare run.
WM11 WM21 • • • WM33	The nine elements (WM_{ij}) of the model attitude transformation matrix $[R_{wm}]$
WNF	Input D-type constant giving model weight tare in pounds for balance normal beam. A card input overrides the value calculated from a tare run.
WPn	Weight flow rate of Flowmeter n
WPNn	Normalized weight flow rate of Flowmeter n
WSF	Input D-type constant giving model weight tare in pounds for balance side beam. A card input overrides the value calculated from a tare run.
WXPM	Input D-type constant giving model x moment tare in inch-pounds for balance pitch beam. A card input overrides the value calculated from a tare run.

Standard Name	Description
WXYM	Input D-type constant giving model x moment tare in inch-pounds for balance yaw beam. A card input overrides the value calculated from a tare run.
WYRM	Input D-type constant giving model y moment tare in inch-pounds for balance roll beam. A card input overrides the value calculated from a tare run.
WYYM	Input D-type constant giving model y moment tare in inch-pounds for balance yaw beam. A card input overrides the value calculated from a tare run.
WZPM	Input D-type constant giving model z moment tare in inch-pounds for balance pitch beam. A card input overrides the value calculated from a tare run.
WZRM	Input D-type constant giving model z moment tare in inch-pounds for balance roll beam. A card input overrides the value calculated from a tare run.
XAFB	Axial force in pounds due to base pressures which is not to be applied as a correction to balance loads

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Standard Name	Description
XAFC	Axial force in pounds due to chamber pressures which is not to be applied as a correction to balance loads
XBAR	Input D-type constant giving x moment transfer distance in inches measured in model axis system
XCAB	Coefficient of axial force due to base pressures which contributed to XAFB.
XCAC	Coefficient of axial force due to chamber pressures which contributed to XAFC
XFLO	Input D-type constant giving cross flow angle in degrees as a yaw rotation from the wind axis to the gravity axis.
XNFB	Normal force in pounds due to base pressures which is not to be applied as a correction to balance loads
XNFC	Normal force in pounds due to chamber pressures which is not to be applied as a correction to balance loads
XPMB	Pitching moment in inch pounds due to base pressures which is not to be applied as a correction to balance loads

Standard Name	Description
XPMC	Pitching moment in inch pounds due to chamber pressures which is not to be applied as a correction to balance loads
XRMB	Rolling moment in inch pounds due to base pressures which is not to be applied as a correction to balance loads
XRMC	Rolling moment in inch pounds due to chamber pressures which is not to be applied as a correction to balance loads
XSFB	Side force in pounds due to base pressures which is not to be applied as a correction to balance loads
XSFC	Side force in pounds due to chamber pressures which is not to be applied as a correction to balance loads
XYMB	Yawing moment in inch pounds due to base pressures which is not to be applied as a correction to balance loads.
XYMC	Yawing moment in inch pounds due to chamber pressures which is not to be applied as a correction to balance loads
YAWG	Gravity axis yaw angle in degrees
YAWI	Initial sting yaw deflection angle in degrees

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Standard Name	Description
YAWS	Sting yaw deflection angle in degrees due to load
YAWW	Yaw angle in degrees
YAWZ	Yaw attitude of the balance with respect to gravity when the wind-off zero is recorded, in degrees
YBAR	Input D-type constant giving y moment transfer distance in inches measured in model axis system
Yn	Flowmeter expansion factor of Flowmeter n
YM	Uncorrected delta yawing moment component (Main balance)
YM2	Uncorrected delta yawing moment component (Second balance)
YMB	Yawing moment in inch pounds due to base pressures which is to be applied as a correction to balance loads
YMBA	Balance axis yawing moment component
YMC	Correct delta yawing moment component
YMCH	Yawing moment in inch pounds due to chamber pressures which is to be applied as a correction to balance loads

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Standard Name	Description
YMDF	Input D-type constant giving yawing moment sting bending deflection constant in degrees/inch-pound
YMMA	Model axis yawing moment component
YMSA	Stability axis yawing moment
YMTA	Yawing moment weight tare component
YMTO	Correct total yawing moment component
YMWA	Wind axis yawing moment
ZBAR	Input D-type constant giving z moment transfer distance in inches measured in model axis system
ZERO	The constant 0.0
ZMUn	Flowmeter fluid viscosity of Flowmeter n

APPENDIX C

RTAT CARD INPUT SPECIFICATIONS

RTAT requires certain input specifications, keywords, and constants in order tc work properly. These are usually input in the form of cards keypunched from input setup sheets. In certain cases, constants may be input through the digital constants panel or through the graphics terminal.

Two basic types of constants are used by the RTAT task. They are classified as SIF-type constants and non-SIF-type constants. SIF-type constants are further subdivided into C-type constants and D-type constants. When RTAT is processing SIF-type constants, it places the constant name in the names disk file and the constant value in the corresponding location in the values disk file. The data base will thus contain either the name for names records or the value for other types of data records. For C-type constants, RTAT searches the names file from the beginning for a matching name. If one is found, the corresponding value in the values file is replaced with the value from the input card and the search in terminated; otherwise the constant is added to the end of the files. Since the data base initially consists of all of the input specifications, C-type constants must be used with great care. D-type constants are added to the end of the files without searching for a matching name.

When RTAT is processing non-SIF-type constants, it places both the constant name and the constant value in both the names and values files. Thus, both the name and the value will be contained in the data base for both names records and other types of data records. The constant value immediately follows the name in the data base. RTAT also uses input keywords and specifications. A keyword is a non-SIF-type constant name which has a definite meaning to RTAT. It may or may not have an associated value. An input specification is an ordered sequence of names and/or values with definite meaning to RTAT. Specifications may be input in blocks which are always identified by a preceeding keyword whose associated value gives the number of specifications in the block. A specification block may be terminated by a keyword.

An entire input setup, consisting of constants, keywords, and specifications, is collectively called the "input constants" or the "setup."

The card input specifications of the extra equation capability are given separately in APPENDIX D.

All input cards are punched free field with a blank as a field delimiter. An asterisk in the first field signifies that the card contains a comment. Names may be optionally bracketed with dollar signs. All names are truncated to four characters with the exception of balance names and balance calibration dates which are truncated to eight characters. Numeric values may be punched as integers or as fixed or floating point constants as desired. All numeric values are stored as real numbers.

In the following card graphics, a vertical line is used to indicate the blank or field delimiter.

APPENDIX C

ENGINEERING UNIT EQUATION SPECIFICATIONS

Engineering unit equations are concerned with converting the raw data inputs obtained from OAP into engineering unit quantities.

```
* CARDS FOR EU SEGMENT
NEU          Enter number of EU equations

OUTPUT   INPUT 1   INPUT 2   EQUATION   SLOPE   INTERCEPT   REFERENCE
NAME     NAME      NAME      TYPE ZERO  VALUE   VALUE       NAME

ENDQ     Collapse E.U. constants from ENDQ
```

The format of each specification is:

Field	Contents	Description
1	Output name	The name to assign to the output EU value computed by this equation.
2	Input 1 name	The data base name to be used as the primary input to this equation.
3	Input 2 name	The data base name to be used as the secondary input to this equation.
4	Equation type and zero option	Two concatenated two-character codes defining the equation type and the zero option to be used.

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Field	Contents	Description
5	Slope	The value of the primary transducer sensitivity to be used by this equation.
6	Intercept	The value of the offset or secondary transducer sensitivity to be used by this equation.
7	Reference name	The data base name to be used as a reference by this equation.

Names used to specify Input 1 and Input 2 must exist in the data base before the equation using them is executed. They may be defined as output names by preceeding engineering unit equations. A name used to specify a reference value must exist in the data base after all engineering unit equations have been executed; hence, it may be defined by a following engineering unit equation.

There are four basic equation types for non-scanivalve data. Each equation type may use two wind-off zero options: yes (YE) or no (NO). If the zero option code for an equation is YE, the zero value will be computed as shown below for each equation type and saved in a special COMMON area whenever a wind-off zero record is processed. If the zero option code is NO, the zero value is stored as 0.0.

Equation type code LI designates a linear equation, computed as:

ZERO = (INPUT1/INPUT2)*SLOPE

OUTPUT = (INPUT1/INPUT2)*SLOPE+INTERCEPT-ZERO+REFERENCE

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Equation type code L2 designates a linear equation with plus and minus slopes, computed as:

IF (INPUT1/INPUT2) < 0, SENS=INTERCEPT

IF (INPUT1/INPUT2) $\geq$ 0, SENS=SLOPE

ZERO = (INPUT1/INPUT2)*SENS

OUTPUT = (INPUT1/INPUT2)*SENS-ZERO+REFERENCE

Equation type code AS designates a Kearfott arcsine equation. Equation type AS ignores the zero option field and always uses a zero option of YE. The equation is computed as:

ZERO = INPUT1-(INPUT2/SLOPE)*SIN(INTERCEPT+REFERENCE)

OUTPUT = ARCSIN((INPUT1-ZERO)*(SLOPE/INPUT2))-INTERCEPT

Equation type code BT designates a linear equation with multiple sensitivities. This equation is used with automatic ranging pressure transducers such as Baratrons and Baracells. These auto ranging transducers may record data in any of seven ranges and change ranges dynamically depending on the magnitude of the pressure being measured. Since each range has its own calibration slope and intercept, it is necessary to know which range was used to record a particular reading in order to apply the proper sensitivity constants. This is accomplished by a second input called the range channel. The range channel is specified by the INPUT 2 name while the data reading is specified by the INPUT 1 name.

APPENDIX C

The range channel may be either an analog channel with various millivolt levels denoting the ranges, or a digital channel with the actual range number available. In either case, the RTAT function IRANGE determines the range number:

RANGE = IRANGE(INPUT2)

where it is required that INPUT2 be available in the data base before the BT equation is executed. RANGE must lie in the interval 1 < RANGE < 7. If the range is invalid, it is assumed to be one.

The calibration slopes and intercepts are expected to immediately follow the BT equation specification in the data base with the following format:

SLOPE1 SLOPE2 . . . SLOPE7	Seven slopes, one per range
INTERCEPT1 INTERCEPT 2 ... INTERCEPT 7	Seven intercepts, one per range

The BT equation therefore is executed as:

RANGE = IRANGE (INPUT2)

SLP = SLOPE(RANGE)

XCPT = INTERCEPT(RANGE)

ZERO = INPUT1*SLP

OUTPUT = INPUT*SLP+XCPT-ZERO+REFERENCE

The zero code for scanivalve data is the port zero option (PO). This may be used with equation types L1, L2, and BT. In the case of scanivalves, the home port (port zero) reading from each data record is used as the ZERO value for that record. The Output name must be specified as a four-character name with at least the last two characters numeric. The generated names will be sequenced by one for each port. The Input 1 name is specified as Sn00 for scanivalve n provided Sn is the OAP channel name for that analog channel. For the BT equation, a range recording for each scanivalve port is required. These range recordings must be contiguous and must be in correspondence to the Input 1 port readings. This is accomplished by a specification such as:

```
P200    S200    S100    BTPO    1.    0.    PI
```

Note that if OAP averaging is utilized, all Baratrons must be set on fixed ranges and not permitted to autorange while a test point is being recorded.

Note that an engineering unit equation which does not fit one of the above types can probably be handled with the extra equation capability invoked before force computations. This capability is described in APPENDIX D.

Number of Balances Card

NBAL		Enter number of balances

For a force test, this card is used to specify the number of balances. The current RTAT maximum is two balances, a main balance and a nose balance. Note that, due to the design of RTAT, the model attitude computations are done within the [illegible] computation modules, therefore, it may be necessary to set NBAL to one rather than zero for a non-force test.

APPENDIX C

Balance Interaction Cards

RTAT permits two methods of entering balance interactions. In the first method, the interaction deck is physically included in the setup deck; while in the second method, the interaction deck is retrieved from a disk file. The card input for the first method is:

INTR

	Index	Value	Value	Value	Value	Value
I						
I						
I						
I						
I						

The block of cards following the INTR card is referred to as an I-card interaction deck. It is designed to load balance information directly into a special COMMON block. The Index field specifies the starting location in COMMON to load the values contained in the subsequent fields. The I-card interaction deck is a standard deck used at Langley which is obtained from a group with the responsibility of maintaining the balance interaction deck library. The contents of the I-card interaction deck are as follows:

Index	Description
1	Balance identification, treated as a name
2	Balance calibration date, treated as a name
3	Balance calibration date in a special integer format
4	Number of balance components physically defined
5-10	Array of balance component names. All balance matrices are arranged in this order.

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Index	Description
11	Code specifying a normal force-pitching moment type balance or a normal force 1-normal force 2 type balance
12	Order of balance calibration
13	Option to translate interactions for initial loads
14	Option for one discontinuous second order interaction
15	Index in First Order Inverse times Second Order matrix for discontinuous second order interaction
16	Maximum number of iterations allowed for convergence
17-52	Inverse of Normalized First Order Interactions with main diagonal elements of unity (First Order Inverse Matrix)
53-179	Product of First Order Inverse Matrix and Normalized Second Order Interactions. (First Order Inverse times Second Order Matrix)
180-185	Positive calibration constants
185-191	Negative calibration constants
192	Percent accuracy required for convergence
193-197	Calibration prime sensitivities
198-203	Accuracy information used to establish the interaction convergence criteria
204-215	Shunt calibration bridge resistances
216	Balance delta weight, the balance weight not measured by the axial beam

APPENDIX C

The card input for the second method is:

	BALANCE NAME	CALIBRATION DATE
BALA		

RTAT considers the balance name and calibration date to be eight character names. RTAT will search a balance history file on the disk for a matching balance name and calibration date. If a match if found, RTAT will replace the BALA card with an INTR card and a copy of the I-card interaction deck obtained from the disk file. No match produces an error message.

The RTAT balance history file is periodically updated and currently contains the following interaction decks:

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Balance Name	Calibration Date
703S	10/20/77
718	08/21/78
725	1-7-74
727	03/14/78
728	04/16/68
729	03/30/78
731	10/29/65
731B	08/01/75
733	11/09/77
736	06/13/77
737-A	10/20/76
737/B	04/21/76
737/B(A/	03/30/76
738	09/19/76
738B	05/16/73
739	06/06/79
747	11/07/78
753	10/16/78
804SA	03/30/79
804SB	03/11/75
832B	10/18/77
832C	07/17/79
832D	10/20/77
833	06/27/79
834	11/16/77
835	11-09-77
836	09/20/77
838	03/30/78
839	07/27/79
840	05/29/79
842A	05-08-78
842-B	11-1-77
843A	02/27/79
843B	07/05/79
847	08/30/76
847-B	07/12/77
UT03-D	08/12/70
UT24-50	05/15/79
UT24-100	03/23/72
UT27-55	09/23/75
UT27-55	09/23/75
UT27-100	08/15/75
UT34A	3/9/78
UT34B	2/14/78
UT37	8/3/78
IR-10-B	03/16/77
IR10-C	01/06/72
IR15	05/08/72
IR21	05/20/77

APPENDIX C

Balance and Model Attitude Cards

The attitude of the balance and the model (with respect to gravity) are specified through an ordered set of Euler rotations.

*ROTATIONS FROM GRAVITY TO BALANCE

NGB		Enter number of rotations

NAME	AXIS

*ROTATIONS FROM BALANCE TO MODEL

NBM		Enter number of rotations

NAME	AXIS

APPENDIX C

The format of each specification is:

Field	Contents	Description
1	Name	Any valid data base name
2	Axis	The name PITC, ROLL, or YAW specifying the axis of rotation

Valid values for NGB and NBM are from zero to twelve.

APPENDIX C

Geometrical Constant Cards

	INPUT NAME	INPUT VALUE
D	S	
D	B	
D	CBAR	
D	REFL	
D	XBAR	
D	YBAR	
D	ZBAR	

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Bending Deflection Constant Cards

	INPUT NAME	INPUT VALUE
D	NFDF	
D	PMDF	
D	SFDF	
D	YMDF	
D	RMDF	

APPENDIX C

Blockage and Jet Boundary Correction Cards

* BLOCKAGE AND JET BOUNDARY CORRECTIONS	
BLK	

Enter 0 to omit and 1 to apply corrections

	INPUT NAME	INPUT VALUE
D	KWI	
D	KBI	
D	J2	
D	J3	

APPENDIX C

Base Pressure Correction Cards

* BASE PRESSURES	
NBAS	

Enter number of pressures

OUTPUT NAME	INPUT NAME	AF	AREAS SF	NF	RM	AREAS*ARMS PM	YM	FLAG

The format of each specification is:

Field	Contents	Description
1	Output name	The name to assign to the individual output pressure coefficient computed from this input pressure
2	Input name	The data base name of this input pressure in pounds/square foot
3	$Area_{AF}$	The area in square feet to be used in computing the axial contribution of this pressure
4	$Area_{SF}$	The area in square feet to be used in computing the side contribution of this pressure
5	$Area_{NF}$	The area in square feet to be used in computing the normal contribution of this pressure

Field	Contents	Description
6	Area*Arm_{RM}	The area times arm in square feet times inches to be used in computing the roll contribution of this pressure
7	Area*Arm_{PM}	The area times arm in square feet times inches to be used in computing the pitch contribution of this pressure
8	Area*Arm_{YM}	The area times arm in square feet times inches to be used in computing the yaw contribution of this pressure
9	FLAG	Flag used to control whether all six force and moment components are to be corrected for the contributions defined by this specification card. If negative, the components are not corrected.

APPENDIX C

Chamber Pressure Correction Cards

* CHAMBER PRESSURES	
NCBR	

Enter number of pressures.

OUTPUT NAME	INPUT NAME	AREAS AF	SF	NF	AREAS*ARMS RM	PM	YM	FLAG

The format of each specification is:

Field	Contents	Description
1	Output name	The name to assign to the individual output pressure coefficien: computed from this input pressure
2	Input name	The data base name of this input pressure in PSF
3	$Area_{AF}$	The area in square feet to be used in computing the axial contribution of this pressure
4	$Area_{SF}$	The area in square feet to be used in computing the side contribution of this pressure
5	$Area_{NF}$	The area in square feet to be used in computing the normal contribution of this pressure

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Field	Contents	Description
6	Area*Arm$_{RM}$	The area times arm in square feet times inches to be used in computing the roll contribution of this pressure
7	Area*Arm$_{PM}$	The area times arm in square feet times inches to be used in computing the pitch contribution of this pressure
8	Area*Arm$_{YM}$	The area times arm in square feet times inches to be used in computing the yaw contribution of this pressure
9	FLAG	Flag used to control whether all six force and moment components are to be corrected for the contributions defined by this specification card. If negative, the components are not corrected.

APPENDIX C

Pressure Coefficient Array Cards

* PRESSURE COEFFICIENT ARRAYS		
NCP		Enter number of CP arrays.

OUTPUT NAME	INPUT NAME	NSIZE

The format of each specification is:

Field	Contents	Description
1	Output name	The first name to be generated and assigned to the first pressure coefficient computed from this array
2	Input name	The data base name of the first pressure in pounds/square foot in this input pressure array
3	NSIZE	The number of pressures in this array

The second through NSIZE output names will be generated by incrementing the trailing digits of the first output name.

The input pressure array must occupy NSIZE sequential locations in the data base.

APPENDIX C

Pressure Coefficient Ratio Cards

```
*     PRESSURE COEFFICIENT RATIOS
NRTC  ________   Enter number of Ratio equations:

OUTPUT          INPUT
 NAME            NAME       SCALAR NAME    NSIZE
```

The format of each specification is:

Field	Contents	Description
1	Output name	The first name to be generated and assigned to the first ratio computed from this array
2	Input name	The data base name of the first element in the input array
3	Scalar name	The data base name of a scalar input value
4	NSIZE	The number of elements in this array

The second through NSIZE output names will be generated by incrementing the trailing digits of the first output name.

The input pressure array must occupy NSIZE sequential locations in the data base.

APPENDIX C

Flowmeter Cards

*	Flowmeters	
NFLO		Enter number of flowmeters

Flowmeter type codes

The flowmeter type codes are as follows:

Type Code	Flow Dyne Serial Number
1	3161
2	3162
3	3163
4	7231
5	7232
6	8332
7	8331
8	8311
9	8312

RTAT contains the calibration information for the nine Venturi-type flowmeters available for use in the 7- by 10-foot high speed tunnel listed above.

APPENDIX C

Real Time Display Cards

* CARDS FOR DISPLAY

NDSP Enter number of names to display.

ENDD Collapse display constants from ENDD.

The format of each specification is:

Field	Contents	Description
1	Name	The data base name of the item to be made available for display
2	Code	The three-digit thumbwheel number to be associated with this data item

The thumbwheel number associated with a data item must be in the range $301 \leq$ code ≤ 997, and must be unique for each item.

APPENDIX C

Point-By-Point Print Cards

* CARDS FOR PRINT SEGMENT	
NPG	

Enter number of specifications

PG						
PG						
PG						
PG						
PG						
PG						
PG						
PG						

ENDP Collapse Print Constants from ENDP

The format of each specification is variable from two to thirteen fields:

Field	Contents	Description
1	Form code	A four-character code word describing the type of printout desired for this specification
2 through 13	Name	A set of one to twelve data base names of data items to be printed under this specification

The form code is a four-character code consisting of the letters "PG" followed by two digits. The digits are used to specify the array size for data to be printed in columnar format. The digits "00" are used for single values.

APPENDIX C

Each specification with form code "PGoo" followed by one to twelve names will cause two lines of output to be printed, which contain the names and the values corresponding to the specified names.

If arrays of values (e.g., sets of scanivalve pressures) are to be printed, a specification with form code "PGnn" followed by one to six names will cause nn lines of output to be printed, each of which will contain the values from one location within the requested arrays. Each array printed with one specification will be arranged as a column down the page. All arrays printed with one specification should contain the same number of values. The specified array name is considered to be associated with the first array location, and the remaining array names are generated by incrementing the trailing digits of the specified name. The remaining array values are obtained from sequentially following locations.

Any name on a specification may be followed by a numerical value which represents the w.d portion of an F format which will be substituted for the default format of F 10.5.

APPENDIX C

Summary Print Cards

* CARDS FOR RUN SUMMARY SEGMENT		
NGP		Enter number of specifications.

GP						
GP						
GP						
GP						
GP						

ENDG	Collapse Print Constants from ENDG

The format of each specification is variable from two to thirteen fields:

Field	Contents	Description
1	Form code	A four-character code word describing the type of printout desired for this specification
2 through 13	Name	A set of one to twelve data base names of data items to be printed under this specification

The form code is a four-character code consisting of the letters "GP" followed by two digits. These digits are used to specify how many names are in that specification.

The files used to save the summary print data do not permit the saving of arrays of data such as pressure coefficient arrays.

APPENDIX C

Any name on a specification may be followed by a numerical value which represents the w.d portion of an F format which will be substituted for the default format of F10.5.

APPENDIX C

Reorder Hookup Cards

NHUK	

Enter number of names.

ENDH

Collapse Recorder Specifications

The format of each specification is that each field contains a data base name.

The reorder cards contain a list of data base names which are relocated to a contiguous set of data base locations. These cards are used to rearrange a pressure hookup into contiguous locations to set up arrays for plotting pressure data. This reordering is done after the data have been printed.

APPENDIX C

Point-By-Point Plot Cards

All RTAT plotting is based on concurrent plotting of one to four x-y plots on a Tektronix 4014 graphics terminal. Each of these plots occupies one quadrant of the screen. Each plot is five units by five units. RTAT only plots current data, that is, no comparison plotting capability is provided.

*POINT BY POINT PLOTS

NPLT Enter number of plots

ENDT Collapse Plot Specifications

The format of each specification consists of 10 fields defined as follows:

Field	Contents	Description
1	X Name	The data base name of the variable for the x-axis
2	X Origin	The value to be assigned to the x-axis origin
3	X Scale	The scale factor for the x-axis
4	X Label	A four-character label to use to annotate the x-axis
5	Y Name	The data base name of the variable for the y-axis

Field	Contents	Description
6	Y Origin	The value to be assigned to the y-axis origin
7	Y Scale	The scale factor for the y-axis
8	Y Label	A four-character label to use to annotate the y-axis
9	Array size	If greater than 1, both x name and y name should contain the same number of values. The specified array name is considered to be associated with the first array location and the remaining array values are assumed to sequentially follow the first in the data base.
10	Symbol code	A code number for the plotting symbol to be used chosen from the following list:

Code	Symbol
1	Circle
2	Tilted-plus
3	Up-Triangle
4	Square
5	Star
6	Tilted-Square
7	Vertical Bar
8	Plus
9	Up-Arrow
10	Down-Arrow
11	Down-Triangle

The values of NPLT are from zero to four.

APPENDIX C

Additional Point By Point Plot Cards

If the NPLT specifications were used to plot pressure data, then an additional set of specifications may be input to plot additional pressure data.

* ADDITIONAL POINT BY POINT PLOTS	
MPLT	

Enter number of plots

ENDM — Collapse Plot Specifications

The format of each specification consists of 10 fields defined as follows:

Field	Contents	Description
1	X Name	The data base name of the variable for the x-axis
2	X Origin	The value to be assigned to the x-axis origin
3	X Scale	The scale factor for the x-axis
4	X Label	A four-character label to use to annotate the x-axis
5	Y Name	The data base name of the variable for the y-axis
6	Y Origin	The value to be assigned to the y-axis origin
7	Y Scale	The scale factor for the y-axis

APPENDIX C

Field	Contents	Description
8	Y Label	A four-character label to use to annotate the y-axis
9	Array size	If greater than 1, both x name and y name should contain the same number of values. The specified array name is considered to be associated with the first array location and the remaining array values are assumed to sequentially follow the first in the data base.
10	Symbol code	A code number for the plotting symbol to be used chosen from the following list:

Code	Symbol
1	Circle
2	Tilted-plus
3	Up-Triangle
4	Square
5	Star
6	Tilted-Square
7	Vertical Bar
8	Plus
9	Up-Arrow
10	Down-Arrow
11	Down-Triangle

The values of MPLT are from zero to four.

APPENDIX C

Summary Plot Cards

* SUMMARY PLOTS		
SPLT		Enter number of plots
ENDS		Collapse Plot Specifications

The format of each specification consists of 10 fields defined as follows:

Field	Contents	Description
1	X Name	The data base name of the variable for the x-axis
2	X Origin	The value to be assigned to the x-axis origin
3	X Scale	The scale factor for the x-axis
4	X Label	A four-character label to use to annotate the x-axis
5	Y Name	The data base name of the variable for the y-axis
6	Y Origin	The value to be assigned to the y-axis origin
7	Y Scale	The scale factor for the y-axis
8	Y Label	A four-character label to use to annotate the y-axis
9	Array size	Must be 1

APPENDIX C

Field	Contents	Description
10	Symbol code	A code number for the plotting symbol to be used chosen from the following list:

Code	Symbol
1	Circle
2	Tilted-plus
3	Up-Triangle
4	Square
5	Star
6	Tilted-Square
7	Vertical Bar
8	Plus
9	Up-Arrow
10	Down-Arrow
11	Down-Triangle

The X Name and Y Name names must be available on the run summary print files. Since arrays cannot be saved on the run summary files in array from, the array size must not be greater than 1.

The values of SPLT are from zero to four.

APPENDIX D

RTAT EXTRA EQUATION CARD INPUT SPECIFICATIONS

Extra Equation Cards

The extra equation capability may be invoked in two places: at the beginning of the NBAL loop before the force computations and at the end of the NBAL loop. The former occurs after engineering units and tunnel parameters are computed and may be used to compute additional engineering unit variables. The latter occurs after UNEEK and may be used to compute additional results. The extra equation capability is invoked within the NBAL loop.

The card input for extra equations at the beginning of the NBAL loop is:

NEXU		Enter number of specification cards

ENDU	Collapse specifications

The contents of the specification cards are described below.

The card input for extra equations at the end of the NBAL loop is:

NEXF		Enter number of specifications cards

ENDX	Collapse specifications

The contents of the specification cards are described below.

APPENDIX D

The extra equation specification cards provide access to a wide range of normal arithmetic operations, special algorithm operations, conditional operations, and tabular data operations. Most of the normal and special operators will handle either scalar variables or one dimensional arrays.

APPENDIX D

Conditional Operator Clauses

The extra equations module implements a conditional operator clause which consists of an IF expression followed by a THEN expression followed by an ELSE expression. An IF expression consists of an IF operator and two input fields. A THEN expression consists of a THEN operator and any operator expression except another conditional operator clause. An ELSE expression consists of an ELSE operator and any operator expression except another conditional operator clause. The IF expression determines whether the THEN expression or the ELSE expression is the one the user desires to execute. Note that, to maintain the integrity of the data base, the non-chosen expression is actually executed with the output set to the special value -9999.0 and the chosen expression is executed normally. Thus one must use conditional operator clauses with care.

APPENDIX D

ABS Operator

Vector absolute value vector. The specification is:

	Output O Name	Input A Name	NSIZE
ABS			

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Output O Name	The name of the result array which is added to the end of the data base
3	Input A Name	The data base name of the input array
4	NSIZE	The number of elements in the o and a arrays

The algorithm executed is

$$o_i = |a_i|$$

where i goes from 1 to NSIZE.

APPENDIX D

ACOS Operator

Vector multiply arccos of scalar. The specification is:

	Output O Name	Input A Name	Input B Name	NSIZE
ACOS				

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Output O Name	The name of the result array which is added to the end of the data base
3	Input A Name	The data base name of the input array
4	Input B Name	The data base name of the input scalar
5	NSIZE	The number of elements in the o and a arrays

The algorithm executed is

$$o_i = a_i * \cos^{-1}(b)$$

where i goes from 1 to NSIZE.

APPENDIX D

ASIN Operator

Vector multiply arcsin of scalar. The specification is:

	Output O Name	Input A Name	Input B Name	NSIZE
ASIN				

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Output O Name	The name of the result array which is added to the end of the data base
3	Input A Name	The data base name of the input array
4	Input B Name	The data base name of the input scalar
5	NSIZE	The number of elements in the o and a arrays

The algorithm executed is

$$o_i = a_i * SIN^{-1}(b)$$

where i goes from 1 to NSIZE.

APPENDIX D

ATAN Operator

Vector multiply arctan of scalar. The specification is:

ATAN	Output O Name	Input A Name	Input B Name	NSIZE
ATAN				

The format of the specification is

Field	Contents	Description
1	Keyword	Operator code
2	Output O Name	The name of the result array which is added to the end of the data base
3	Input A Name	The data base name of the input array
4	Input B Name	The data base name of the input scalar
5	NSIZE	The number of elements in the o and a arrays

The algorithm executed is

$$o_i = a_i * TAN^{-1}(b)$$

where i goes from 1 to NSIZE.

APPENDIX D

ATNZ Operator

Vector multiply arctan of scalar ratio. The specification is:

	Output O Name	Input A Name	Input B Name	Input C Name	NSIZE
ATN2					

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Output O Name	The name of the result array which is added to the end of the data base
3	Input A Name	The data base name of the input array
4	Input B Name	The data base name of the first input scalar
5	Input C Name	The data base name of the second input scalar
6	NSIZE	The number of elements in the o and a arrays

The algorithm executed is

$$o_i = a_i * TAN^{-1}(b/c)$$

where i goes from 1 to NSIZE.

APPENDIX D

CAI Operator

Scalar internal drag axial force coefficient. The specification is:

	Output O Name	Input A Name	Input B Name	Input C Name
CAI				

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Output O Name	The name of the result scalar which is added to the end of the data base
3	Input A Name	The data base name of the first input scalar
4	Input B Name	The data base name of the second input scalar
5	Input C Name	The data base name of the third input scalar

The algorithm executed is

$$o = [(\frac{b}{P1} * \{(\frac{c}{MACH}) * \cos(ALPW) * (\frac{1 + \frac{c^2}{5}}{1 + \frac{MACH^2}{5}}) - (\frac{c^2}{MACH^2})\} - (\frac{b - P1}{QINF})](\frac{a}{S})$$

where Input A is exit area, Input B is exit static pressure, Input C is exit Mach number. S, P1, MACH, QINF, and ALPW are obtained from the data base.

inputs must be in compatible units. Note that the result is for a single engine.

APPENDIX D

CAS Operator

Vector multiply cos of scalar add vector multiply sin of scale.

The specification is:

	Output O Name	Input A Name	Input B Name	Input C Name	Input D Name	NSIZE
CAS						

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Output O Name	The name of the result array which is added to the end of the data base
3	Input A Name	The data base name of the first input array
4	Input B Name	The data base name of the first input scalar
5	Input C Name	The data base name of the second input array
6	Input D Name	The data base name of the second input scalar
7	NSIZE	The number of elements in the o, a, and c arrays

APPENDIX D

The algorithm executed is

$$o_i = a_i * COS(b) + c_i * SIN(d)$$

where i goes from ' to NSIZE.

APPENDIX D

CNI Operator

Scalar internal drag normal force coefficient. The specification is:

	Output Name	Input A Name	Input B Name	Input C Name
CNI				

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Output Name	The name of the result scalar which is added to the end of the data base
3	Input A Name	The data base name of the first input scalar
4	Input B Name	The data base name of the second input scalar
5	Input C Name	The data base name of the third input scalar

The algorithm executed is

$$o = \left(\frac{a}{S}\right) * \frac{b}{PI} * \frac{c}{MACH} * SIN(ALPW) * \left(\frac{1 + \frac{c^2}{5}}{1 + \frac{MACH^2}{5}}\right)^{1/2}$$

where Input A is exit area, Input B is exit static pressure, Input [illegible] is exit Mach number. S, P1, MACH, and ALPW are obtained from the data base.

The inputs must be in compatible units. Note that the result is for a single engine.

APPENDIX D

COS Operator

Vector multiply cos of scalar, The specification is:

	Output O Name	Input A Name	Input B Name	NSIZE
COS				

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Output O Name	The name of the result array which is added to the end of the data base
3	Input A Name	The data base name of the input array
4	Input B Name	The data base name of the input scalar
5	NSIZE	The number of elements in the o and a arrays

The algorithm executed is

$$o_i = a_i * COS(b)$$

where i goes from 1 to NSIZE.

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APPENDIX D

CP Operator

Vector pressure coefficient. The specification is:

	Output O Name	Input A Name	NSIZE
CP			

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Output O Name	The name of the result array which is added to the end of the data base
3	Input A Name	The data base name of the input array
4	NSIZE	The number of elements in the o and a arrays

The algorithm executed is

$$o_i = (a_i - P1)QINF$$

where i goes from 1 to NSIZE, P1 and QINF are obtained from the data base. Input A, P1, and QINF must be in compatible units.

APPENDIX D

CSS Operator

Vector multiply cos of scalar subtract vector multiply sin of scalar.

The specification is:

	Output O Name	Input A Name	Input B Name	Input C Name	Input D Name	NSIZE
CSS						

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Output O Name	The name of the result array which is added to the end of the data base
3	Input A Name	The data base name of the first input array
4	Input B Name	The data base name of the first input scalar
5	Input C Name	The data base name of the second input array
6	Input D Name	The data base name of the second input scalar
7	NSIZE	The number of elements in the o, a, and c arrays

The algorithm executed is

$$o_i = a_i * \mathrm{COS}(b) - c_i * \mathrm{SIN}(d)$$

where i goes from 1 to NSIZE.

APPENDIX D

ELSE Operator

The specification is:

$\boxed{\text{ELSE}}$

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code

APPENDIX D

EXP Operator

Vector exponential scalar. The specification is:

	Output O Name	Input A Name	Input B Name	NSIZE
EXP				

The format of the specification is:

Field	Contents	Descritpion
1	Keyword	Operation code
2	Output O Name	The name of the result array which is added to the end of the data base
3	Input A Name	The data base name of the input array
4	Input B Name	The data base name of the input scalar
5	NSIZE	The number of elements in the o and a arrays

The algorithm executed is

$$o_i = (a_i)^b$$

where i goes from 1 to NSIZE.

APPENDIX D

IFEQ Expression

If equal expression. The specification is:

	Input A Name	Input B Name
IFEQ		

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Input A Name	The data base name of the first input scalar
3	Input B Name	The data base name of the second input scalar

The algorithm executed is:

If a = b, execute the THEN expression,

otherwise execute the ELSE expression.

APPENDIX D

IFGE Expression

If greater than or equal expression. The specification is:

	Input A Name	Input B Name
IFGE		

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Input A Name	The data base name of the first input scalar
3	Input B Name	The data base name of the second input scalar

The algorithm executed is:

If a $\geq$ b, execute the THEN expression,

otherwise execute the ELSE expression.

APPENDIX D

IFGT Expression

If greater than expression. The specification is:

	Input A Name	Input B Name
IFGT		

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Input A Name	The data base name of the first input scalar
3	Input B Name	The data base name of the second input scalar

The algorithm executed is:

If a > b, execute the THEN expression,

otherwise execute the ELSE expression.

APPENDIX D

IFLE Expression

If less than or equal expression. The specification is:

	Input A Name	Input B Name
IFLE		

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Input A Name	The data base name of the first input scalar
3	Input B Name	The data base name of the second input scalar

The algorithm executed is:

If $a \leq b$, execute the THEN expression,

otherwise execute the ELSE expression.

APPENDIX D

IFLT Expression

If less than expression. The specification is:

	Input A Name	Input B Name
IFLT		

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Input A Name	The data base name of the first input scalar
3	Input B Name	The data base name of the second input scalar

The algorithm executed is:

If a < b, execute the THEN expression,

otherwise execute the ELSE expression.

APPENDIX D

IFNE Expression

If not equal expression. The specification is:

	Input A Name	Input B Name
IFNE		

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Input A Name	The data base name of the first input scalar
3	Input B Name	The data base name of the second input scalar

The algorithm executed is:

If $a \neq b$, execute the THEN expression,

otherwise execute the ELSE expression.

APPENDIX D

MACH Operator

Scalar Mach number. The specification is:

	Output O Name	Input A Name	Input B Name
MACH			

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Output O Name	The name of the result scalar which is added to the end of the data base
3	Input A Name	The data base of the first input scalar
4	Input B Name	The data base name of the second input scalar

The algorithm executed is

$$o = \sqrt{5\left(\left(\frac{b}{a}\right)^{2/7} - 1\right)}$$

where Input A is a static pressure and Input B is a total pressure. Input A and Input B must be in compatible units.

APPENDIX D

MFLO Operator

Scalar mass flow ratio. The specification is:

	Output O Name	Input A Name	Input B Name	Input C Name	Input D Name
MFLO					

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Output O Name	The name of the resultant scalar which is added to the end of the data base
3	Input A Name	The data base name of the first input scalar
4	Input B Name	The data base name of the second input scalar
5	Input C Name	The data base name of the third input scalar
6	Input D Name	The data base name of the fourth input scalar

The algorithm executed is

$$o = \frac{a * b * c}{RHO * d * VINF}$$

where Input A is an exit density, Input B is an exit area, Input C is an exit velocity, Input D is an inlet area, RHO and VINF are obtained from the data base. The inputs must be in compatible units.

APPENDIX D

NOOP Operator

No Operation. The specification is:

$\boxed{\text{NOOP}}$

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code

This specification performs no operation.

APPENDIX D

RHO Operator

Scalar density. The specification is:

	Output O Name	Input A Name	Input B Name	Input C Name
RHO				

The format of the specificaion is:

Field	Contents	Description
1	Keyword	Operation code
2	Output O Name	The name of the result scalar which is added to the end of the data base
3	Input A Name	The data base name of the first input scalar
4	Input B Name	The data base name of the second input scalar
5	Input C Name	The data base name of the third input scalar

The algorithm executed is

$$o = [(a - .379 * PSAT_{TDEW})/(53.3 * 32.17 * c)] * [1/(1 + \frac{b^2}{5})^{5/2}]$$

where Input A is a total pressure in psf, Input B is a Mach number, Input C is a total temperature in degrees Rankine, and $PSAT_{TDEW}$ is the vapor pressure at the dew point temperature TDEW. TDEW is obtained from the data base. Output O is in slugs/ft^3.

APPENDIX D

SET Operator

Reset data base to value. The specification is:

	Input A Name	Value	NSIZE
SET			

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Input A Name	The data base name of an array whose values are to be reset
3	Value	The actual scalar value for the new value
4	NSIZE	The number of elements in the a array

The algorithm executed is

$$a_i = \text{value}$$

where i goes from 1 to NSIZE. Note that a forward search of the data base is used to locate Input A Name. This is designed to be executed at the beginning of the NBAL loop to permit setting values for any variable which the force computations would use a forward search to retrieve.

APPENDIX D

SETN Operator

Reset data base to name. The specification is:

	INPUT A NAME	INPUT B NAME	NSIZE
SETN			

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Input A Name	The data base name of an array whose values are to be reset
3	Input B Name	The data base name of an array whose values are to be used as the new values
4	NSIZE	The number of elements in the a and b arrays

The algorithm executed is

$$a_i = b_i$$

where i goes from 1 to NSIZE. Note that a forward search of the data base is used to locate Input A Name and a backward search of the data base is used to locate Input B Name. This is designed to be used at the beginning of the NBAL loop to permit setting values for any variable which the force computations would use a forward search to retrieve.

APPENDIX D

SIN Operator

Vector multiply sin of scalar. The specification is:

	Output O Name	Input A Name	Input B Name	NSIZE
SIN				

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Output O Name	The name of the result array which is added to the end of the data base
3	Input A Name	The data base name of the input array
4	Input B Name	The data base name of the input scalar
5	NSIZE	The number of elements in the o and a arrays

The algorithm executed is

$$o_i = a_i * \mathrm{SIN}(b)$$

where i goes from 1 to NSIZE.

APPENDIX D

SSC Operator

Vector multiply sin of scalar subtract vector multiply cos of scalar.

The specification is:

	Output O Name	Input A Name	Input B Name	Input C Name	Input D Name	NSIZE
SSC						

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Output O Name	The name of the result array which is added to the end of the data base
3	Input A Name	The data base name of the first input array
4	Input B Name	The data base name of the first input scalar
5	Input C Name	The data base name of the second input array
6	Input D Name	The data base name of the second input scalar
7	NSIZE	The number of elements in the o, a, and c arrays

APPENDIX D

The algorithm executed is

$$o_i = a_i * \mathrm{SIN}(b) - c_i * \mathrm{COS}(d)$$

where i goes from 1 to NSIZE.

APPENDIX D

SUMV Operator

Summation of vector. The specification is:

	Output O Name	Input A Name	NSIZE
SUMV			

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Output O Name	The name of the result scalar which is added to the end of the data base
3	Input A Name	The data base name of the input array
4	NSIZE	The number of elements in the array

The algorithm executed is

$$o = \sum_{i=1}^{NSIZE} a_i$$

APPENDIX D

TAB1 Operator

One dimensional table lookup with linear interpolation. The specification is:

	Output O Name	Input A Name	NROW
TAB1			

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Output O Name	The name of the result scalar which is to be added to the end of the data base
3	Input A Name	The name of the input scalar
4	NROW	The number of independent variable A values in the following table

The specification of the immediately following table is:

Independent Variable A Value	Dependent Variable Value

APPENDIX D

The format of the specification is:

Field	Contents	Description
1	Independent Variable A Value	The value of the independent variable corresponding to the Input A name
2	Dependent Variable Value	The value of the dependent variable corresponding to the Output O Name

The algorithm executed is a one-dimensional table lookup with linear interpolation and extrapolation.

APPENDIX D

TAB2 Operator

Two dimensional table lookup with linear interpolation. The specification is:

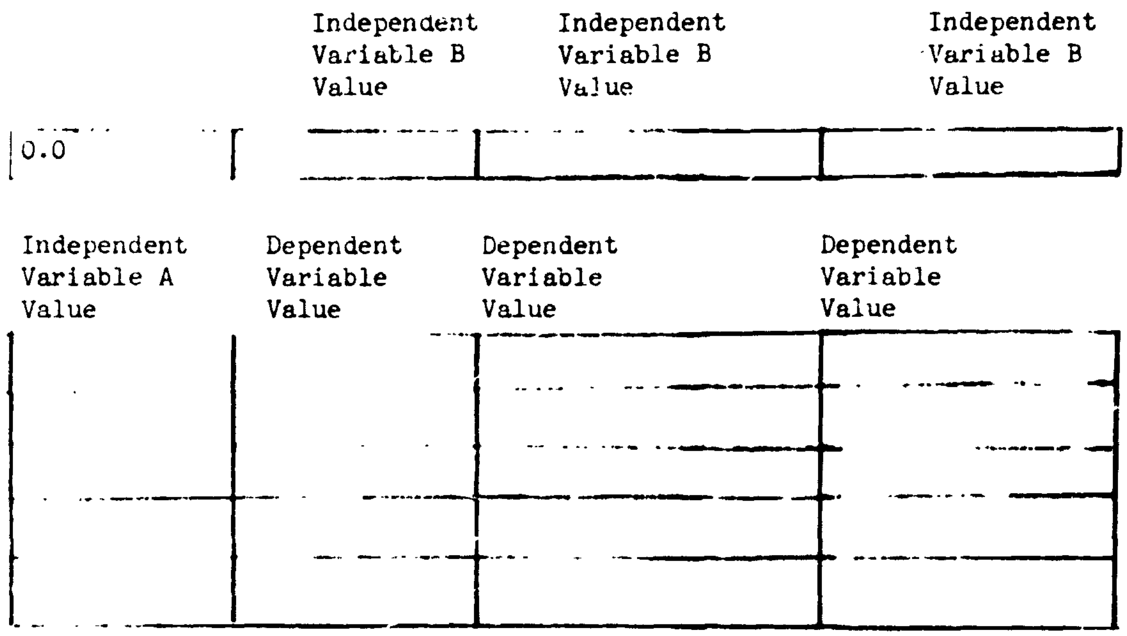
	Output Name	Input A Name	Input B Name	NROW	NCOL
TAB2					

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Output O Name	The name of the result scalar which is to be added to the end of the data base
3	Input A Name	The name of the first input scalar
4	Input B Name	The name of the second input scalar
5	NROW	The number of independent variable A values in the following table
6	NCOL	The number of independent variable B values in the following table

APPENDIX D

The specification of the immediately following table is:



The format of the first row of the specification is:

Field	Contents	Description
1	0.0	Dummy value to force table alignment
2 → NCOL	Independent variable B values	The value of the independent variable corresponding to the Input B Name

The format of the second through NROW rows of the specification is:

Field	Contents	Description
1	Independent variable A values	The value of the independent variable corresponding to the Input A Name
2 → NCOL	Dependent variable value	The value of the dependent variable corresponding to the Output O Name

The algorithm executed is a two-dimensional table lookup with linear interpolation and extrapolation.

APPENDIX D

TAB3 Operator

Slope and intercept table lookup. The specification is:

	Output Name	Input A Name	NROW
TAB3			

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Output O Name	The name of the result scalar which is to be added to the end of the data base
3	Input A Name	The name of the input scalar
4	NROW	The number of independent variable A values in the following table

The specification of the immediately following table is:

Independent Variable A Value	Slope Value	Intercept Value

APPENDIX D

The format of the specification is:

Field	Contents	Description
1	Independent variable A value	The value of the independent variable corresponding to the Input A Name
2	Slope value	The value of the slope of a piecewise linear fit to the dependent variable value corresponding to the Output O Name
4	Intercept value	The value of the intercept of a piecewise linear fit to the dependent variable value corresponding to the Output O Name

The algorithm executed is

$$o = a * (\text{Slope})_i + (\text{Intercept})_i$$

where

$$(\text{Independent Variable A})_{i-1} < a \leq (\text{Independent Variable A})_i$$

APPENDIX D

TAB4 Operator

One-dimensional table lookup with exact match. The specification is:

	Output Name	Input A Name	NROW
TAB4			

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Output O Name	The name of the result scalar which is to be added to the end of the data base
3	Input A Name	The name of the input scalar
4	NROW	The number of independent variable A values in the following table

The specification of the immediately following table is:

Independent Variable A Value	Dependent Variable Value

APPENDIX D

The format of the specification is:

Field	Contents	Description
1	Independent variable A value	The value of the independent variable corresponding to the Input A name
2	Dependent variable value	The value of the dependent variable corresponding to the Output O Name

The algorithm executed is a one-dimensional table lookup with one to one correspondence. If no match is found, an error message is generated.

APPENDIX D

TAN Operator

Vector multiply tan of scalar. The specification is:

	Output O Name	Input A Name	Input B Name	NSIZE
TAN				

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Output O Name	The name of the result array which is added to the end of the data base
3	Input A Name	The data base name of the input array
4	Input B Name	The data base name of the input scalar
5	NSIZE	The number of elements in the o and a arrays

The algorithm executed is

$$o_i = a_i * \mathrm{TAN}(b)$$

where i goes from 1 to NSIZE.

APPENDIX D

TCJ Operator

Vector Iron/Constantan thermocouple temperature. The specification is:

	OUTPUT O NAME	INPUT A NAME	NSIZE
TCJ			

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Output O Name	The name of the result array which is added to the end of the data base
3	Input A Name	The data base name of the input array
4	NSIZE	The number of elements in the o and a arrays

The algorithm executed is a linear interpolation in an iron/constantan or iron/copper-nickel thermocouple table (a Type J thermocouple) for a cold junction at $32^{o}F$. The Input A is in absolute millivolts and the Output O is in ^{o}F.

APPENDIX D

TCK Operator

Vector Chromel/Alumel thermocouple temperature. The specification is:

	OUTPUT O NAME	INPUT A NAME	NSIZE
TCK			

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Output O Name	The name of the result array which is added to the end of the data base
3	Input A Name	The data base name of the input array
4	NSIZE	The number of elements in the o and a arrays

The algorithm executed is a linear interpolation in a chromel/alumel or nickel-chromium/nickel-aluminum thermocouple table (a Type K thermocouple) for a cold junction at 32°F. The Input A is in absolute millivolts and the Output O is in °F.

APPENDIX D

THEN Operator

The specification is:

$\boxed{\text{THEN}}$

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code

APPENDIX D

VAAV Operator

Vector add vector add vector. The specification is:

	Output O Name	Input A Name	Input B Name	Input C Name	NSIZE
VAAV					

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Output O Name	The name of the result array which is added to the end of the data base
3	Input A Name	The data base name of the first input array
4	Input B Name	The data base name of the second input array
5	Input C Name	The data base name of the third input array
6	NSIZE	The number of elements in the o, a, b, and c arrays

The algorithm executed is

$$o_i = a_i + b_i + c_i$$

where i goes from 1 to NSIZE.

APPENDIX D

VAS Operator

Vector add scalar. The specification is:

	Output O Name	Input A Name	Input B Name	NSIZE
VAS				

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Output O Name	The name of the result array which is added to the end of the data base
3	Input A Name	The data base name of the input array
4	Input B Name	The data base name of the input scalar
5	NSIZE	The number of elements in the o and a arrays

The algorithm executed is

$$o_i = a_i + b$$

where i goes from 1 to NSIZE.

APPENDIX D

VASQ Operator

Sum of squared vectors. The specification is:

	Output O Name	Input A Name	Input B Name	NSIZE
VASQ				

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Output O Name	The name of the result array which is added to the end of the data base
3	Input A Name	The data base name of the first input array
4	Input B Name	The data base name of the second input array
5	NSIZE	The number of elements in the o, a, and b arrays

The algorithm executed is

$$o_i = a_i^2 + b_i^2$$

where i goes from 1 to NSIZE.

APPENDIX D

VAV Operator

Vector add vector. The specification is:

	Output O Name	Input A Name	Input B Name	NSIZE
VAV				

Field	Contents	Description
1	Keyword	Operation code
2	Output O Name	The name of the result array which is added to the end of the data base
3	Input A Name	The data base name of the first input array
4	Input B Name	The data base name of the second input array
5	NSIZE	The number of elements in the o, a, and b arrays

The algorithm executed is:

$$o_i = a_i + b_i$$

where i goes from 1 to NSIZE.

APPENDIX D

VAVG Operator

Vector average. The specification is:

	Output O Name	Input A Name	Input B Name	NSIZE
VAVG				

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Output O Name	The name of the result array which is added to the end of the data base
3	Input A Name	The data base name of the first input array
4	Input B Name	The data base name of the second input array
5	NSIZE	The number of elements in the o, a, and b arrays

The algorithm executed is

$$o_i = (a_i + b_i)/2$$

where i goes from 1 to NSIZE.

APPENDIX D

VDS Operator

Vector divide scalar. The specification is:

	Output O Name	Input A Name	Input B Name	NSIZE
VDS				

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Output O Name	The name of the result array which is added to the end of the data base.
3	Input A Name	The data base name of the input array
4	Input B Name	The data base name of the input scalar
5	NSIZE	The number of elements in the o and a arrays

The algorithm executed is

$$o_i = a_i/b$$

where i goes from 1 to NSIZE.

APPENDIX D

VDV Operator

Vector divide vector. The specification is:

	Output O Name	Input A Name	Input B Name	NSIZE
VDV				

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Output O Name	The name of the result array which is added to the end of the data base
3	Input A Name	The data base name of the first input array
4	Input B Name	The data base name of the second input array
5	NSIZE	The number of elements in the o, a, and b arrays

The algorithm executed is

$$o_i = a_i/b_i$$

where i goes from 1 to NSIZE.

APPENDIX D

VEL Operator

Scalar speed. The specification is:

VEL	Output O Name	Input A Name	Input B Name

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Output O Name	The name of the result scalar which is added to the end of the data base
3	Input A Name	The data base name of the first input scalar
4	Input B Name	The data base name of the second input scalar

The algorithm executed is

$$o = \sqrt{1.4 * 53.3 * 32.17 * b * (1/(1 + \frac{a^2}{5}))}$$

where Input A is a Mach number and Input B is a total temperature in degrees Rankine. Output O is in feet per second.

APPENDIX D

VMMV Operator

Vector multiply vector multiply vector. The specification is:

	Output O Name	Input A Name	Input B Name	Input C Name	NSIZE
VMMV					

The format of the specirication is:

Field	Contents	Description
1	Keyword	Operation code
2	Output O Name	The name of the result array which is added to the end of the data base
3	Input A Name	The data base name of the first input array
4	Input B Name	The data base name of the second input array
5	Input C Name	The data base name of the third input array
6	NSIZE	The number of elements in the o, a, b, and c arrays

The algorithm executed is

$$o_i = a_i * b_i * c_i$$

where i goes from 1 to NSIZE.

APPENDIX D

VMS Op[illegible]tor

Vector multiply scalar. The specification is:

	Output O Name	Input A Name	Input B Name	NSIZE
VMS				

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Output O Name	The name of the result array which is added to the end of the data base
3	Input A Name	The data base name of the input array
4	Input B Name	The data base name of the input scalar
5	NSIZE	The number of elements in the o and a arrays

The algorithm executed is

$$o_i = a_i * b$$

where i goes from 1 to NSIZE.

APPENDIX D

VMV Operator

Vector multiply vector. The specification is:

	Output O Name	Input A Name	Input B Name	NSIZE
VMV				

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Output O Name	The name of the result array which is added to the end of the data base
3	Input A Name	The data base name of the first input array
4	Input B Name	The data base name of the second input array
5	NSIZE	The number of elements in the o, a, and b arrays

The algorithm executed is

$$o_i = a_i * b_i$$

where i goes from 1 to NSIZE.

APPENDIX D

VSS Operator

Vector subtract scalar. The specification is:

	Output O Name	Input A Name	Input B Name	NSIZE
VSS				

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Output O Name	The name of the result array which is added to the end of the data base
3	Input A Name	The data base name of the input array
4	Input B Name	The data base name of the input scalar
5	NSIZE	The number of elements in the o and a arrays

The algorithm executed is

$$o_i = a_i - b$$

where i goes from 1 to NSIZE.

APPENDIX D

VSSQ Operator

Difference of squared vectors. The specification is:

VSSQ	Output O Name	Input A Name	Input B Name	NSIZE

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Output O Name	The name of the result array which is added to the end of the data base
3	Input A Name	The data base name of the first input array
4	Input B Name	The data base name of the second input array
5	NSIZE	The number of elements in the o, a, and b arrays

The algorithm executed is

$$o_i = a_i^2 - b_i^2$$

where i goes from 1 to NSIZE.

APPENDIX D

VSV Operator

Vector subtract vector. The specification is:

	Output O Name	Input A Name	Input B Name	NSIZE
VSV				

The format of the specification is:

Field	Contents	Description
1	Keyword	Operation code
2	Output O Name	The name of the result array which is added to the end of the data base
3	Input A Name	The data base name of the first input array
4	Input B Name	The data base name of the second input array
5	NSIZE	The number of elements in the o, a, and b arrays

The algorithm executed is

$$o_i = a_i - b_i$$

where i goes from 1 to NSIZE.

APPENDIX E

RTAT INTERACTIVE CALIBRATION

SPECIFICATIONS AND EXAMPLES

Once the calibration data are acquired, RTAT contains the capability to work up the following types of calibrations:

(a) Linear transducers

(b) Kearfott accelerometers

(c) Balance spans

(d) Sting bendings

The interactive device may be either the teletype or the Tektronix 4014 graphics terminal. The Tektronix should be set in small character size with AUTO PRINT on and MARGIN CONTROL 1 on. The Tektronix hard copy unit should be on.

The general steps in a simple calibration session are: begin calibration session, specify type of calibration and options, specify PROCESS directive, specify VOID name directive, specify NAME channel directive, specify VOID point directive, specify CHANGE data directive, computer calibration, and output results. The formats of the directives are given below.

APPENDIX E

Calibration Type Directive

The specification is:

TYPE	OPTION 1	OPTION 2	OPTION 3

The format of the specification is:

Field	Contents	Description
1	Keyword	XDCR indicates linear transducer calibration. KFTT indicates Kearfott arcsine calibration. BSPN indicates balance span calibration. BNDG indicates sting bending calibration.
2	Option 1 flag	A zero or blank turns the option off. A one turns the option on. If on, the user must identify the dependent and independent variables. If off, the dependent variable is the first name in the NAME channel directive and the following names are the independent variables in the order in which the calibrations are to be performed.

Field	Contents	Description
3	Option 2 flag	A zero or blank turns the option off. A one turns the option on. If on, all communication will be via the card reader (not recommended). If off, communication will be via the interactive device.
4	Option 3 flag	A zero or blank turns the option off. A one turns the option on. If on, the calibration will be worked up before corrections are requested. If off, corrections will be solicited before the first workup.

Option 1 may not be turned on for types BSPN and BNDG. Option 3 may not be turned on for type BSPN. The usual selection is all three options turned off, thus normally only the first field needs to be specified.

APPENDIX E

Process Directive

The specification is:

PROC	NAME 1	VALUE 1	NAME 2	VALUE 1	THRU	NAME 1	VALUE 2	NAME 2	VALUE 2

The format of the specification is:

Field	Contents	Description
1	Keyword	Directive name
2	Name 1	First calibration file variable name
3	Value 1	Starting value of first calibration file variable name
4	Name 2	Second calibration file variable name
5	Value 1	Starting value of second calibration file variable name
6	THRU	Keyword, inclusive through
7	Name 1	First calibration file variable name
8	Value2	Ending value of first calibration file variable name
9	Name 2	Second calibration file variable name
10	Value 2	Ending value of second calibration file variable name

Name 2 Value 1 and Name 2 Value 2 are optional on this specification.

Name 1 Value 1 THRU Name 1 Value 2 are also optional on this specification.

This directive is used to select that portion of the calibration input file which the calibration session will use. The basic command requires only the first field and uses the entire calibration input file.

APPENDIX E

VOID Name Directive

The specification is:

	NAME	VALUE		VALUE	VALUE		VALUE	
VOID			THRU			THRU		-1

The format of the specification is:

Field	Contents	Description
1	Keyword	Directive name
2	Name	Calibration file variable name
3	Value	Starting value of calibration file variable name
4	THRU	Keyword, inclusive through
5	Value	Ending value of calibration file variable name
6	Value	Starting value of calibration file variable name
7	THRU	Keyword, inclusive through
8	Value	Ending value of calibration file variable name
9	-1	Directive terminator

THRU is optional in this specification. Value THRU Value may be repeated as often as required in this specification. The null form of this directive has two forms:

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(a) the directive name and directive terminator, and

(b) the directive terminator.

This directive voids for the entire calibration session.

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NAME Channel Directive

The specification is:

NAME	NAME 1	THRU	NAME 2	TP1	TP2	-1

The format of the specification is:

Field	Contents	Description
1	Keyword	Directive name
2	Name 1	First calibration file variable name
3	THRU	Keyword, inclusive through
4	Name 2	Second calibration file variable name
5	TP1	Starting Test Point number
6	TP2	Ending Test Point number
7	-1	Directive terminator

TP1 and TP2 are optional in this specification. THRU is optional in this specification. Name 1 THRU Name 2 may be repeated as often as required in this specification. NAME is also optional in this specification. This directive, in conjunction with the option 1 flag of the calibration type directive, specifies the names of the dependent and independent variables to be read from the calibration input file for each test point.

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VOID Point Directive

The specification is:

	NAME	VALUE 1		VALUE 2	
VOID			THRU		-1

The format of the specification is:

Field	Contents	Description
1	Keyword	Directive name
2	Name	Calibration file variable name, for example, TP for test point number
3	Value 1	Starting value of calibration file variable name
4	THRU	Keyword, inclusive through
5	Value 2	Ending value of calibration file variable name
6	-1	Directive terminator

THRU is optional in this specification. Value 1 THRU Value 2 may be repeated as often as required in this specification.

The null form of this directive has three forms:

(a) the directive name and directive terminator;

(b) the directive terminator; and

(c) the directive name.

During a calibration session, the void points accumulate. The input of the directive name alone will clear out all previous void points.

APPENDIX E

CHANGE Data Directive

The specification is:

	NAME	TP	VALUE	
CHAN				-1

The format of the specification is:

Field	Contents	Description
1	Keyword	Directive name
2	Name	Calibration file variable name
3	TP	Test Point number
4	Value	New value to be used
5	-1	Directive terminator

Name TP Value may be repeated as often as required in this specification.

The null form of this directive has three forms:

(a) the directive name and directive terminator;

(b) the directive terminator; and

(c) the directive name.

During a calibration session, the change points accumulate. The input of the directive name alone will clear out all previous change points.

APPENDIX E

RESTART Directive

The specification is:

$\boxed{\text{REST}}$

The format of the specification is:

Field	Contents	Description
1	Keyword	Directive name

This directive can be input any time a directive is requested. This directive causes RTAT to re-initialize the calibration session.

APPENDIX E

Delete Input Line Directive

The specification is:

BLANK	
	D

The format of the specification is:

Field	Contents	Description
1	Blank	Blank
2	Keyword	Directive Name, the letter D

This directive may be appended to any input line. This directive causes the current input line to be deleted and permits the user to re-enter that input line.

APPENDIX E

Linear Transducer Calibration (XDCR)

The linear transducer calibration type is used with absolute and differential linear transducers such as Statham pressure gages.

Multiple transducer calibrations may be performed during a calibration session. The calibration input data must have been previously recorded and saved on the RAD file CALMV. The load channel is usually defined on the Digital Constants Panel and is therefore also recorded with the transducer readings on CALMV. The load values should be input in the correct units.

For the linear transducer calibration, the object is to determine the SLOPE and INTERCEPT which appear in the following equation:

Dependent variable = SLOPE * Independent variable + INTERCEPT

where a least square fit is performed using all data points.

The output of the calibration consists of a listing of the input data, the calibration constants, the deviation of each point from the calibration equation, the root mean square error, the point number of the point having maximum deviation, and the average power supply voltage.

APPENDIX E

Kearfott Accelerometer Calibration (KFTT)

The Kearfott accelerometer calibration is designed specifically for the special arcsine equation used for Kearfott accelerometer attitude sensors.

Multiple Kearfott calibrations may be performed during a calibration session. The calibration input data must have been previously recorded and saved on the RAD file CALMV. The load channel is usually defined on the Digital Constants Panel and is therefore also recorded with the accelerometer readings on CALMV. The load values should be input in the correct units.

For the Kearfott calibration, the object is to determine A, C, and PHIO which appear in the following equation:

$$\text{Dependent variable} = \arcsin\left(\frac{\text{Independent variable} - C}{A}\right) - \text{PHIO}$$

where a least square fit is performed using all data points.

The output of the calibration is a listing of the input data, the calibration constants, the deviation of each point from the calibration equation, the root mean square error, the point number of the point having maximum deviation, and the average power supply voltage.

APPENDIX E

Balance Span Calibration (BSPN)

The balance span calibration is designed specifically to work up balance shunt spans and compute balance sensitivity constants.

Only one balance span may be performed during a calibration session. The calibration input data must have been previously recorded and saved on the RAD file CALMV. The span codes are usually defined in a digital channel set up for thumbwheel input and are therefore also recorded on CALMV.

The balance span calibration requires the six balance components in consecutive analog channels in the order NF,AF,PM,RM,YM,SF, the power supply voltage channel, and the span code channel.

The span code word identifies the analog channel number for NF, identifies the balance component being spanned, and identifies the type of span load. The span code word is considered an integer as follows:

Span Code Word	Value	Description
units digit	1	zero load
	2	span load
	3	return zero load
tens digit	1	normal span
	2	axial span
	3	pitch span
	4	roll span
	5	yaw span
	6	side span
thousands digit and hundreds digit combined		analog channel number of normal force channel

APPENDIX E

If any portion of the balance span is unsatisfactory, a complete new balance span must be recorded.

If the balance span is satisfactory, the user has the option to apply the span to the balance laboratory calibration to obtain the sensitivity constants as installed in the tunnel. To do this, the user must know the current values of the laboratory prime sensitivity constants, the laboratory span, and the laboratory power supply voltage. For convenience, these are usually punched on cards in the order noted and in the expected balance component order.

RTAT then calculates the tunnel sensitivity constants from:

$$\text{Tunnel sensitivity constant} = (\text{Laboratory sensitivity constant}) * \left(\frac{\text{Laboratory span}}{\text{Tunnel span}}\right)$$

where

$$\text{Tunnel span} = \left\{\left(\frac{\text{Tunnel Span Load Reading}}{\text{Tunnel Power Supply Voltage}} - \frac{1}{2}\left[\frac{\text{Tunnel Zero Load Reading}}{\text{Tunnel Power Supply Voltage}} + \frac{\text{Tunnel Return Zero Load Reading}}{\text{Tunnel Power Supply Voltage}}\right]\right) * (\text{Laboratory Power Supply Voltage})\right\}$$

APPENDIX E

The output of the calibration consists of a listing of the input data, the tunnel spans, the tunnel sensitivity constants, and the average tunnel balance voltage.

APPENDIX E

Sting Bending Calibration (BNDG)

The sting bending calibration is designed to work up combined sting and balance deflection constants for either single components or paired components.

Multiple bending calibrations may be performed during a calibration session. The calibration input data are normally previously recorded manually and punched on cards for input to RTAT.

The format of the calibration input deck is a header card followed by data cards followed by one or more trailer cards.

The specification of the header card is:

Btype

The format of the specification is:

Field	Contents	Description
1	Btype	Keyword NF indicates normal force bending PM indicates pitching moment bending SF indicates side force bending YM indicates yawing moment bending RM indicates rolling moment bending LONG indicates combined normal force and pitching moment bending LAT indicates combined side force and yawing moment bending ROLL indicates rolling moment bending

APPENDIX E

Note that the names of the independent variables are determined from the Btype.

The specification of the bending data cards is:

TP	LOCATION	LOAD	DEG	MIN	SEC

The format of the specification is:

Field	Contents	Description
1	TP	An ascending point number which will be used by PROCESS, VOID, and CHANGE DIRECTIVES
2	LOCATION	The location of the applied load with respect to the balance moment center in inches
3	LOAD	The applied load in pounds
4	DEG	The degrees portion of the angle
5	MIN	The minutes portion of the angle
6	SEC	The seconds portion of the angle

Note that the bending calibration uses the name DEFL for the dependent variable which it computes as follows:

$$\mathrm{DEFL} = \mathrm{DEG} + \frac{\mathrm{MIN}}{60} + \frac{\mathrm{SEC}}{3600}$$

The bending calibration is not aware of trigonometric indentities such as $360^\circ = 0^\circ$. (The bending calibration is actually a special type of linear transducer calibration.) Care must be exercised in specifying the deflection angles in order to obtain correct results. In view of the definition of DEFL, an angle such as 358°20'50" should be input as the DEG MIN SEC string -1 -39 -10.

The specification of the trailer card is:

END

The format of the specification is:

Field	Contents	Description
1	Keyword	One END card terminates a Btype. Two END cards terminate all bending input.

For the bending calibration, the object is to determine the values of C0, C1, and C2 which appear in the following equation:

$$\text{Dependent variable} = C0 + C1 * (\text{Independent variable } 1) + C2 * (\text{Independent variable } 2)$$

where a least square fit is performed over all data points.

The output of the calibration consists of a listing of the input data, the calibration constants, the deviation of each point from the calibration equation, the root mean square error, and the point number of the point having maximum deviation.

APPENDIX F

Sample Interactive Calibration Sessions

The following examples represent simple interactive calibration sessions using the Tektronics graphics terminal. The stylized arrow is the system prompt character for the graphics terminal. The user supplied input follows the prompt character and is terminated by a carriage return.

The following is an interactive linear transducer calibration session.

```
INPUT CALIBRATION TYPE('XDCR','KFTT','BNDG','RSPN') AND OPTIONS

--->XDCR

INPUT PROCESS DIRECTIVE

--->PROCESS TP 17778 THRU TP 17790

INPUT VOID NAME DIRECTIONS

--->-1

INPUT NAME DIRECTIVE (INPUT CHANNEL NAMES)

INCLUDE NAMES OF POWER SUPPLY VOLTAGE CHANNELS

THE DEFAULT IS THAT THE FIRST CHANNEL NAMED IS THE LOAD CHANNEL

--->LOAD S300 S301 S400 S401 A46 -1

INPUT NUMBER OF CALIBRATIONS TO BE PERFORMED

--->4

INPUT NAME OF CHANNEL CONTAINING POWER SUPPLY VOLTAGE

--->A46

INPUT VOID POINT INSTRUCTION

--->-1

INPUT CHANGE INFO
CHANNEL NAME,POINT NO.,NEW VALUE

--->-1
```

7X10 HIGH SPEED TUNNEL XDCR CALIBRATION

CURRENTLY USING XDCR CHANNELS LOAD AND S300

PT. NO.	LOAD	MV	DEVIATION
17778.	0.0000	7.4780	-0.7244E+00
17779.	144.0000	12.8080	-0.5248E+00
17780.	288.0000	18.1560	-0.8109E+00
17781.	432.0000	23.4750	-0.3141E+00
17782.	576.0000	28.7840	0.4519E+00
17783.	720.0000	34.0790	0.1596E+01
17784.	0.0000	7.4440	0.1929E+00
17785.	-144.0000	2.1130	0.2024E-01
17786.	-288.0000	-3.2180	-0.1524E+00
17787.	-432.0000	-8.5690	0.2145E+00
17788.	-576.0000	-13.9090	0.2847E+00
17789.	-720.0000	-19.2740	0.1629E+01
17790.	0.0000	7.4980	-0.1264E+01

```
RMS =  0.74176E+00
MAX DEV =  0.15959E+01
PT. NO. =17783.

AVERAGE POWER SUPPLY VOLTAGE =  0.5992E+01
SLOPE      =       26.9794
INTERCEPT =     -201.8278

HAPPY?   TYPE IN 'YES' OR 'NO'

--->YES

INPUT NAME OF CHANNEL CONTAINING POWER SUPPLY VOLTAGE

--->A46

INPUT VOID POINT INSTRUCTION

--->-1
```

```
INPUT CHANGE INFO
CHANNEL NAME,POINT NO.,NEW VALUE

--->-1

7X10 HIGH SPEED TUNNEL XDCR CALIBRATION

 CURRENTLY USING XDCR CHANNELS LOAD AND 5301

  PT. NO.        LOAD          MV   DEVIATION
   17778.      0.0000     7.4770 -0.6891E+00
   17779.    144.0000    12.8070 -0.5008E+00
   17780.    288.0000    18.1620 -0.9931E+00
   17781.    432.0000    23.4740 -0.3220E+00
   17782.    576.0000    28.7740  0.6727E+00
   17783.    720.0000    34.0780  0.1559E+01
   17784.      0.0000     7.4480  0.9333E-01
   17785.   -144.0000     2.1220 -0.1999E+00
   17786.   -288.0000    -3.2140 -0.2233E+00
   17787.   -432.0000    -8.5810  0.5897E+00
   17788.   -576.0000   -13.9150  0.5123E+00
   17789.   -720.0000   -19.2610  0.7587E+00
   17790.      0.0000     7.4980 -0.1256E+01

RMS =  0.76281E+00
MAX DEV =  0.15595E+01
PT. NO. =17783.

AVERAGE POWER SUPPLY VOLTAGE =   0.5992E+01
SLOPE      =          26.9821
INTERCEPT =     -201.0561

HAPPY?   TYPE IN 'YES' OR 'NO'

--->YES

INPUT NAME OF CHANNEL CONTAINING POWER SUPPLY VOLTAGE

--->A46
```

```
INPUT VOID POINT INSTRUCTION

--->-1

INPUT CHANGE INFO
CHANNEL NAME,POINT NO.,NEW VALUE

--->-1

7X10 HIGH SPEED TUNNEL XDCR CALIBRATION

 CURRENTLY USING XDCR CHANNELS LOAD AND S400

  PT. NO.       LOAD        MV   DEVIATION
   17778.     0.0000    2.3810  0.2430E+00
   17779.   144.0000    8.2040  0.4722E+00
   17780.   288.0000   14.0540  0.3469E-01
   17781.   432.0000   19.9090 -0.5262E+00
   17782.   576.0000   25.7520 -0.7909E+00
   17783.   720.0000   31.5900 -0.9321E+00
   17784.     0.0000    2.3580  0.8109E+00
   17785.  -144.0000   -3.4880  0.1150E+01
   17786.  -288.0000   -9.2980  0.5995E+00
   17787.  -432.0000  -15.1200  0.3457E+00
   17788.  -576.0000  -20.9130 -0.6293E+00
   17789.  -720.0000  -26.6910 -0.1964E+01
   17790.     0.0000    2.3430  0.1181E+01

RMS =  0.88391E+00
MAX DEV = -0.19645E+01
PT. NO. =17789.

AVERAGE POWER SUPPLY VOLTAGE =   0.5992E+01
SLOPE      =       24.6902
INTERCEPT  =      -59.0303

HAPPY?   TYPE IN 'YES' OR 'NO'
```

```
--->YES

INPUT NAME OF CHANNEL CONTAINING POWER SUPPLY VOLTAGE

--->A46

INPUT VOID POINT INSTRUCTION

--->-1

INPUT CHANGE INFO
CHANNEL NAME.POINT NO..NEW VALUE

--->-1

7X10 HIGH SPEED TUNNEL XDCR CALIBRATION

 CURRENTLY USING XDCR CHANNELS LOAD AND S401

  PT. NO.       LOAD          MV   DEVIATION
   17778.     0.0000      2.3780  0.3095E+00
   17779.   144.0000      8.2050  0.4357E+00
   17780.   288.0000     14.0600 -0.1296E+00
   17781.   432.0000     19.9080 -0.5221E+00
   17782.   576.0000     25.7450 -0.6427E+00
   17783.   720.0000     31.5890 -0.9365E+00
   17784.     0.0000      2.3590  0.7787E+00
   17785.  -144.0000     -3.4800  0.9489E+00
   17786.  -288.0000     -9.2960  0.5511E+00
   17787.  -432.0000    -15.1350  0.7213E+00
   17788.  -576.0000    -20.9220 -0.3925E+00
   17789.  -720.0000    -26.6780 -0.2272E+01
   17790.     0.0000      2.3440  0.1149E+01

RMS =  0.91277E+00
MAX DEV = -0.22717E+01
PT. NO. =17789.

AVERAGE POWER SUPPLY VOLTAGE =   0.5992E+01
```

```
SLOPE      =      24.6909
INTERCEPT  =     -59.0245

HAPPY?   TYPE IN 'YES' OR 'NO'

--->YES

TO BEGIN NEW CALIBRATION SESSION TYPE IN 'CONTINUE'. TO STOP TYPE IN 'STOP'

--->STOP
```

The following is an interactive Kearfott calibration session.

```
INPUT CALIBRATION TYPE('XDCR','KFTT','BNDG','BSPN') AND OPTIONS

--->KFTT

INPUT PROCESS DIRECTIVE

--->PROCESS TP 17716 THRU TP 17725

INPUT VOID NAME DIRECTIONS

--->-1

INPUT NAME DIRECTIVE (INPUT CHANNEL NAMES)

INCLUDE NAMES OF POWER SUPPLY VOLTAGE CHANNELS

THE DEFAULT IS THAT THE FIRST CHANNEL NAMED IS THE LOAD CHANNEL

--->LOAD A32 A28 -1

INPUT NUMBER OF CALIBRATIONS TO BE PERFORMED

--->1

INPUT NAME OF CHANNEL CONTAINING POWER SUPPLY VOLTAGE

--->A26

INPUT VOID POINT INSTRUCTION

--->-1

INPUT CHANGE INFO
CHANNEL NAME,POINT NO.,NEW VALUE

--->-1
```

7X10 HIGH SPEED TUNNEL KFTT CALIBRATION

CURRENTLY USING KFTT CHANNELS LOAD AND A32

PT. NO.	ANGLE	MV	DEVIATION
17716.	0.0000	2.8370	0.2655E-01
17717.	-5.0000	-15.4930	0.6998E-03
17718.	-10.0000	-33.7120	-0.7159E-02
17719.	-15.0000	-51.6770	0.2215E-02
17720.	-18.0000	-62.2120	-0.2041E-02
17721.	5.0000	21.4610	-0.1599E-01
17722.	10.0000	39.8010	-0.1177E-01
17723.	15.0000	57.9480	-0.2033E-01
17724.	16.0000	61.3580	0.2774E-01
17725.	0.0000	2.9310	0.1104E-02

RMS = 0.15418E-01
MAX DEV = 0.27738E-01
PT. NO. =17724.

AVERAGE POWER SUPPLY VOLTAGE = 0.2980E+02
C = 7.8597
A = 211.6810
PHIO = -1.3330
1./A = 0.00478409

HAPPY? TYPE IN 'YES' OR 'NO'

--->YES

TO BEGIN NEW CALIBRATION SESSION TYPE IN 'CONTINUE'. TO STOP TYPE IN 'STOP'

--->CONT

INPUT CALIBRATION TYPE('XDCR','KFTT','BNDG','RSPN') AND OPTIONS

--->KFTT

INPUT PROCESS DIRECTIVE

```
--->PROCESS TP 17736 THRU TP 17742

INPUT VOID NAME DIRECTIONS

--->-1

TYPE IN CHANNEL NAMES
INCLUDE NAMES OF POWER SUPPLY CHANNELS

--->LOAD A33 A29 -1

INPUT NUMBER OF CALIBRATIONS TO BE PERFORMED

--->1

INPUT NAME OF CHANNEL CONTAINING POWER SUPPLY VOLTAGE

--->A29

INPUT VOID POINT INSTRUCTION

--->-1

INPUT CHANGE INFO
CHANNEL NAME,POINT NO.,NEW VALUE

--->-1

7X10HIGH SPEED TUNNEL KFTT CALIBRATION

 CURRENTLY USING KFTT CHANNELS LOAD AND A33

  PT. NO.      ANGLE          MV   DEVIATION
   17736.     0.0000     -5.2690 -0.3949E-01
   17737.    -1.0000     -8.1360 -0.2248E-01
   17738.     5.0000      8.6680  0.1137E-01
   17739.    10.0000     22.6720  0.2118E-02
   17740.    15.0000     36.5030 -0.2031E-01
```

```
   17741.   20.0000   49.8750  0.1106E-01
   17742.    0.0000   -5.5480  0.5947E-01

RMS =  0.29929E-01
MAX DEV =  0.59469E-01
PT. NO. =17742.

AVERAGE POWER SUPPLY VOLTAGE =   0.59469E-01
C     =    -4.7062
A     =   161.5245
PHIO =    -0.2392
1./A =   0.00619101

HAPPY?   TYPE IN 'YES' OR 'NO'

--->YES

TO BEGIN NEW CALIBRATION SESSION TYPE IN 'CONTINUE'  TO STOP TYPE IN 'STOP'

--->STOP
```

The following is an interactive balance span session.

```
INPUT CALIBRATION TYPE('XDCR','KFTT','BNDG','BSPN') AND OPTIONS

--->BSPN

INPUT NAME OF CHANNEL CONTAINING SPAN CODES
(THE DEFAULT '-1' USES: D166)

--->-1

INPUT PROCESS DIRECTIVE

--->PROCESS

INPUT VOID NAME DIRECTIONS

--->-1

INPUT NAME DIRECTIVE (INPUT CHANNEL NAMES)

THE CHANNELS ARE SPECIFIED IN THE ORDER: NF AF PM RM YM SF VOLTAGE

THE DEFAULT -1 USES: A1 A2 A3 A4 A5 A6 A41

--->-1

INPUT VOID POINT INSTRUCTION

--->-1

7X10 HIGH SPEED TUNNEL BALANCE SPAN CALIBRATION

TEST      32
RUN       1

    POINT       NF        AF        PM        RM        YM        SF     VOLTAGE

NF 17935     0.61[illegible]    0.1480    0.6100   -1.8020   -0.2090    0.0830    5.0[illegible]
```

	17936	7.3180	0.1580	0.0090	-1.8030	-0.2090	0.0820	5.0020
	17937	0.6140	0.1580	0.6100	-1.8030	-0.2100	0.0820	5.0030
AF	17938	0.6140	0.1590	0.6100	-1.8030	-0.2100	0.0820	5.0020
	17939	0.6140	6.8590	0.6100	-1.8030	-0.2090	0.0820	5.0030
	17940	0.6140	0.1590	0.6110	-1.8030	-0.2090	0.0820	5.0030
PM	17941	0.6140	0.1590	0.6110	-1.8020	-0.2080	0.0820	5.0020
	17942	0.6150	0.1600	7.3090	-1.8020	-0.2080	0.0820	5.0020
	17943	0.6140	0.1610	0.6100	-1.8020	-0.2090	0.0830	5.0020
RM	17944	0.6140	0.15[illegible]	0.6100	-1.8030	-0.2080	0.0820	5.0020
	17945	0.6150	0.1580	0.6110	4.8980	-0.2090	0.0820	5.0010
	17946	0.6140	0.1580	0.6100	-1.8030	-0.2090	0.0820	5.0010
YM	17947	0.6150	0.1590	0.6100	-1.8040	-0.2100	0.0830	5.0030
	17948	0.6140	0.1610	0.6110	-1.8020	6.4900	0.0830	5.0020
	17949	0.6140	0.1510	0.6110	-1.8020	-0.2090	0.0830	5.0020
SF	17950	0.6150	0.1530	0.6100	-1.8030	-0.2090	0.0830	5.0020
	17951	0.6150	0.1530	0.6110	-1.8030	-0.2090	6.7870	5.0010
	17952	0.6140	0.1550	0.6120	-1.8020	-0.2090	0.0830	5.0020

HAPPY SO FAR? TYPE IN 'YES' OR 'NO'

--->YES

IS CONSTANTS INPUT BY CARDS DESIRED? INPUT 'YES' OR 'NO'

--->YES

CARD INPUT MUST BE IN THIS ORDER: NF, AF, PM, RM, YM, SF

7X10 HIGH SPEED TUNNEL BALANCE SPAN CALIBRATION

	CALCULATED SENS CONST	RECORDED SPAN GAGE	RECORDED VOLTAGE	CALIBRATION SENS CONST	CALIBRATION SPAN	CALIBRATION GAGE VOLTAGE
NF	180.47269	6.70088	5.00233	934.57861	1.33700	5.00000
AF	1[illegible].83596	6.69597	5.00267	70.29048	1.33700	5.00000

PM	45[illegible].06104	6.69582	5.00200	2255.63843	1.33600	5.00000
RM	21[illegible].30482	6.69948	5.00133	1055.59399	1.33600	5.00000
YM	251.93843	6.69630	5.00233	1264.75513	1.33400	5.00000
SF	10[illegible].27612	6.70268	5.00167	518.13403	1.33600	5.00000

TO BEGIN NEW CALIBRATION SESSION TYPE IN 'CONTINUE'. TO STOP TYPE IN 'STOP'

--->STOP

The following is an interactive bending calibration session.

INPUT CALIBRATION TYPE('XDCR','KFTI','BNDG','RSPN') AND OPTIONS

--->BNDG
IS DATA INPUT BY CARDS DESIRED? TYPE IN 'YES' OR 'NO'

--->YES

INPUT VOID POINT INSTRUCTION

--->-1

INPUT CHANGE INSTRUCTION
CHANNEL NAME, POINT NO.,NEW VALUE

--->-1

7X10 HIGH SPEED TUNNEL BENDING CALIBRATION

CURRENTLY USING:
DEPENDENT CHANNEL NAME: DEFL
INDEPENDENT CHANNEL NAME(S): NF PM

CALC. = C0 + C1*NF + C2*PM
C0 = -0.26616E+00
C1 = 0.52269E-02
C2 = 0.71814E-03

POINT	DEFL	CALC.	DEVIATION	NF	PM
1.	-0.27639E+00	-0.26616E+00	-0.10232E-01	0.00000E+00	0.00000E+0
2.	0.24167E+00	0.25653E+00	-0.14867E-01	0.10000E+03	0.00000E+0
3.	0.77917E+00	0.77922E+00	-0.57757E-04	0.20000E+03	0.00000E+0
4.	0.12944E+01	0.13019E+01	-0.74720E-02	0.30000E+03	0.00000E+0
5.	0.18153E+01	0.18246E+01	-0.93286E-02	0.40000E+03	0.00000E+0
6.	0.13306E+01	0.13019E+01	0.28640E-01	0.30000E+03	0.00000E+0
7.	0.29583E+00	0.25653E+00	0.39300E-01	0.10000E+03	0.00000E+0
8.	-0.27639E+00	-0.26616E+00	-0.10232E-01	0.00000E+00	0.00000E+0
9.	-0.27639E+00	-0.26616E+00	-0.10232E-01	0.00000E+00	0.00000E+0

```
 10.   0.39444E+00   0.40016E+00  -0.57170E-02   0.10000E+03   0.20000E+03
 11.   0.10611E+01   0.10665E+01  -0.53701E-02   0.20000E+03   0.40000E+03
 12.   0.17111E+01   0.17328E+01  -0.21688E-01   0.30000E+03   0.60000E+03
 13.   0.23722E+01   0.23991E+01  -0.26896E-01   0.40000E+03   0.80000E+03
 14.   0.17694E+01   0.17328E+01   0.36645E-01   0.30000E+03   0.60000E+03
 15.   0.45417E+00   0.40016E+00   0.54005E-01   0.10000E+03   0.20000E+03
 16.  -0.27500E+00  -0.26616E+00  -0.88428E-02   0.10000E+03   0.20000E+03
 17.  -0.27500E+00  -0.26616E+00  -0.88428E-02   0.00000E+03   0.20000E+03
 18.   0.90278E-01   0.11291E+00  -0.22628E-01   0.10000E+03  -0.20000E+03
 19.   0.48472E+00   0.49197E+00  -0.72463E-02   0.20000E+03  -0.40000E+03
 20.   0.86111E+00   0.87103E+00  -0.99202E-02   0.30000E+03  -0.60000E+03
 21.   0.12431E+01   0.12501E+01  -0.70381E-02   0.40000E+03  -0.80000E+03
 22.   0.88750E+00   0.87103E+00   0.16469E-01   0.30000E+03  -0.60000E+03
 23.   0.13333E+00   0.11291E+00   0.20428E-01   0.10000E+03  -0.20000E+03
 24.  -0.27500E+00  -0.26616E+00  -0.88428E-02   0.00000E+00   0.00000E+00

RMS =  0.20608E-01
MAX DEV =  0.54005E-01
PT. NO. =   15.

HAPPY?   TYPE IN 'YES' OR 'NO'

--->YES

DO YOU WANT TO CONTINUE BENDING CALIBRATION WITH CURRENT DATA?
TYPE IN 'YES' OR 'NO'

--->NO

TO BEGIN NEW CALIBRATION SESSION TYPE IN 'CONTINUE'. TO STOP TYPE IN 'STOP'

--->CONTINUE

INPUT CALIBRATION TYPE('XDCR','KFTT','BNDG','RSPN') AND OPTIONS

--->BNDG
IS DATA INPUT BY CARDS DESIRED?  TYPE IN 'YES' OR 'NO'

--->YES
```

```
INPUT VOID POINT INSTRUCTION

--->-1

INPUT CHANGE INSTRUCTION
CHANNEL NAME, POINT NO., NEW VALUE

--->-1

7X10 HIGH SPEED TUNNEL BENDING CALIBRATION

CURRENTLY USING:
DEPENDENT CHANNEL NAME: DEFL
INDEPENDENT CHANNEL NAME(S): SF    YM

CALC. = C0 + C1*SF    + C2*YM
C0  =  -0.27901E+00
C1  =   0.53469E-02
C2  =   0.86172E-03
```

POINT	DEFL	CALC.	DEVIATION	SF	YM
25.	-0.27917E+00	-0.27901E+00	-0.15807E-03	0.00000E+00	0.00000E+00
26.	-0.40278E-01	-0.11663E-01	-0.28615E-01	0.50000E+02	0.00000E+00
27.	0.25000E+00	0.25568E+00	-0.56827E-02	0.10000E+03	0.00000E+00
28.	0.52500E+00	0.52303E+00	0.19716E-02	0.15000E+03	0.00000E+00
29.	0.78889E+00	0.79037E+00	-0.14852E-02	0.20000E+03	0.00000E+00
30.	0.28750E+00	0.25568E+00	0.31817E-01	0.10000E+03	0.00000E+00
31.	-0.27500E+00	-0.27901E+00	-0.15807E-03	0.00000E+00	0.00000E+00
32.	-0.27500E+00	-0.27901E+00	-0.15807E-03	0.00000E+00	0.00000E+00
33.	0.48611E-01	0.74509E-01	-0.25898E-01	0.50000E+02	0.10000E+03
34.	0.42639E+00	0.42803E+00	-0.16382E-02	0.10000E+03	0.20000E+03
35.	0.77500E+00	0.78154E+00	-0.65449E-02	0.15000E+03	0.30000E+03
36.	0.11264E+01	0.11351E+01	-0.86746E-02	0.20000E+03	0.40000E+03
37.	0.46389E+00	0.42803E+00	0.35862E-01	0.10000E+03	0.20000E+03
38.	-0.27361E+00	-0.27901E+00	0.53975E-02	0.00000E+00	0.00000E+00
39.	-0.27361E+00	-0.27901E+00	0.53975E-02	0.00000E+00	0.00000E+00
40.	-0.12083E+00	-0.97835E-01	-0.22998E-01	0.50000E+02	-0.10000E+03
41.	0.77778E-01	0.83338E-01	-0.55606E-02	0.10000E+03	-0.20000E+03

```
    42.   0.26528E+00   0.26451E+00   0.76586E-03   0.15000E+03  -0.30000E+03
    43.   0.44167E+00   0.44569E+00  -0.40188E-02   0.20000E+03  -0.40000E+03
    44.   0.10139E+00   0.83338E-01   0.18050E-01   0.10000E+03  -0.20000E+03
    45.  -0.22500E+00  -0.27901E+00   0.40086E-02   0.00000E+00   0.00000E+00

RMS =  0.15362E-01
MAX DEV =  0.35862E-01
PT. NO. =   37.

HAPPY?   TYPE IN 'YES' OR 'NO'

--->YES

DO YOU WANT TO CONTINUE BENDING CALIBRATION WITH CURRENT DATA?
TYPE IN 'YES' OR 'NO'

--->NO

TO BEGIN NEW CALIBRATION SESSION TYPE IN 'CONTINUE'. TO STOP TYPE IN 'STOP'

--->CONTINUE

INPUT CALIBRATION TYPE('XDCR','KFTT','BNDG','RSPN') AND OPTIONS

--->BNDG

IS DATA INPUT BY CARDS DESIRED? TYPE IN 'YES' OR 'NO'

--->YES

INPUT VOID POINT INSTRUCTION

--->-1

INPUT CHANGE INSTRUCTION
CHANNEL NAME,POINT NO.,NEW VALUE

--->-1
```

7X10 HIGH SPEED TUNNEL BENDING CALIBRATION

CURRENTLY USING:
DEPENDENT CHANNEL NAME: DEFL
INDEPENDENT CHANNEL NAME(S): RM

CALC. = CO + C1*RM
CO = 0.17004E+01
C1 = 0.23395E-02

POINT	DEFL	CALC.	DEVIATION	RM
46.	0.16528E+01	0.17004E+01	-0.47623E-01	0.00000E+00
47.	0.18792E+01	0.19343E+01	-0.55182E-01	0.10000E+03
48.	0.21111E+01	0.21683E+01	-0.57185E-01	0.20000E+03
49.	0.23833E+01	0.24022E+01	-0.18909E-01	0.30000E+03
50.	0.22319E+01	0.21683E+01	0.63648E-01	0.20000E+03
51.	0.20333E+01	0.19343E+01	0.98986E-01	0.10000E+03
52.	0.17167E+01	0.17004E+01	0.16267E-01	0.00000E+00

RMS = 0.57389E-01
MAX DEV = 0.98986E-01
PT. NO. = 51.

HAPPY? TYPE IN 'YES' OR 'NO'

--->YES

DO YOU WANT TO CONTINUE BENDING CALIBRATION WITH CURRENT DATA?
TYPE IN 'YES' OR 'NO'

--->NO

TO BEGIN NEW CALIBRATION SESSION TYPE IN 'CONTINUE'. TO STOP TYPE IN 'STOP'

--->STOP

APPENDIX F

RTAT SAMPLE SETUP DECKS

The following examples represent simple RTAT setup decks for several types of tests.

These examples are for the tunnel setup only. The setup for the static room would consist of a set of input cards similar to the ones following the RBM job control cards but specifying the appropriate static room channels. Note that OAP can be setup for the tunnel and static room in any order. Similarly RTAT can be setup for the tunnel and static room in any order. Care should be exercised to avoid conflicts between the tunnel and the static room RTAT setups in the ucse of Tektronix 4014 graphics terminal. Note that all display thumbwheel assignments must be unique.

The following is an RTAT setup deck for a pressure model test.

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!JOB   OAP-7 PLUS RTAT-4.4     SAMPLE DECK SETUP FOR A PRESSURE MODEL
!PAUSE KEYIN FG.S         MOUNT RAW DATA TAPE ON M9
!REWIND M9
!ASSIGN UD=GX.F
!ASSIGN F:500=F500.UD.F
!ASSIGN F:501=F501.UD.F
!ASSIGN F:502=F502.UD.F
!ASSIGN F:503=F503.UD.F
!ASSIGN F:504=F504.UD.F
!ASSIGN F:505=F505.UD.F
!ASSIGN F:511=F511.UD.F
!ASSIGN F:106=LP.F
!ASSIGN F:11=M3.F
!ASSIGN F:11=0.F
!ASSIGN M1=M9.F
!ASSIGN M2=M9.F
!ASSIGN F:101=CVALUE.UD.F
!ASSIGN F:102=CNAME.UD.F
!ASSIGN F:103=TARES.UD.F
!ASSIGN F:104=CALMV.UD.F
!ASSIGN F:108=CALSCR.UD.F
!ASSIGN F:107=CALDATA.FD.F
!ASSIGN F:120=CDATA.UD.F
!ASSIGN F:121=SYSCAL.UD.F
!ASSIGN F:122=CBAL.UD.F
!ASSIGN F:100=OAP.UP.F
!ASSIGN CL=CALDATA.FD.F
!ASSIGN L1=OAP.UP.F
!ASSIGN F:1=GX.F
!ASSIGN F:600=F600.UD.F
!ASSIGN F:601=F601.UD.F
!ASSIGN F:602=F602.UD.F
!ASSIGN F:603=F603.UD.F
!ASSIGN F:604=F604.UD.F
!ASSIGN F:605=F605.UD.F
!ASSIGN F:611=F611.UD.F
!ASSIGN F:123=SNAME.UD.F
!ASSIGN F:124=CCOM.UD.F
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!ASSIGN F:301=CVALU2,UD,F
!ASSIGN F:302=CNAME2,UD,F
!ASSIGN F:303=TARES2,UD,F
!ASSIGN F:304=CALMV2,UD,F
!ASSIGN F:321=SYSCA2,UD,F
!ASSIGN F:323=SNAME2,UD,F
!ASSIGN F:324=CCOM2,UD,F
!ASSIGN F:125=KNAME,UD,F
!ASSIGN F:325=KNAME2,UD,F
!ASSIGN F:126=A0,F
!ASSIGN F:127=B0,F
!ASSIGN F:2=GX,F
!OAP
9END
!EOD
1 CHNO,1 FSET,1 NAME,NF
1 CHNO,2 FSET,1 NAME,AF
1 CHNO,3 FSET,1 NAME,PM
1 CHNO,4 FSET,1 NAME,RM
1 CHNO,5 FSET,1 NAME,YM
1 CHNO,6 FSET,1 NAME,SF
1 CHNO,7 FSET,2 OFST,0.0 NAME,PC1
1 CHNO,8 FSET,2 OFST,0.0
1 CHNO,9 FSET,2 OFST,0.0
1 CHNO,10 FSET,2 OFST,0.0
1 CHNO,11 FSET,2 OFST,0.0
1 CHNO,12 FSET,2 OFST,0.0
1 CHNO,13 FSET,2 OFST,0.0
1 CHNO,14 FSET,2
1 CHNO,15 FSET,1
1 CHNO,16 FSET,1
1 CHNO,17 FSET,1
1 CHNO,18 FSET,1
1 CHNO,19 FSET,1
1 CHNO,20 FSET,1
1 CHNO,21 FSET,2 OFST,0.0 NAME,S1
1 CHNO,22 FSET,2 OFST,0.0 NAME,S2
1 CHNO,23 FSET,2 OFST,0.0 NAME,S3
1 CHNO,24 FSET,2 OFST,0.0 NAME,S4
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```
1 CHNO,25 FSET,2
1 CHNO,26 FSET,2
1 CHNO,27 FSET,2
1 CHNO,28 FSET,2
1 CHNO,29 FSET,2
1 CHNO,30 FSET,1
1 CHNO,31 FSET,1
1 CHNO,32 FSET,1
1 CHNO,33 FSET,1 OFST,0.0 NAME,PIND
1 CHNO,34 FSET,1 OFST,0.0
1 CHNO,35 FSET,2 OFST,0.0 NAME,TDEW
1 CHNO,36 FSET,2 OFST,0.0 NAME,TT
1 CHNO,37 FSET,2 OFST,0.0
1 CHNO,38 FSET,2 OFST,0.0
1 CHNO,39 FSET,2 OFST,0.0
1 CHNO,40 FSET,2
1 CHNO,41 FSET,2 OFST,0.0 NAME,G1
1 CHNO,42 FSET,2 OFST,0.0 NAME,G2
1 CHNO,43 FSET,2 OFST,0.0 NAME,G3
1 CHNO,44 FSET,2 OFST,0.0 NAME,G4
1 CHNO,45 FSET,2 OFST,0.0 NAME,G5
1 CHNO,46 FSET,2 OFST,0.0 NAME,G6
1 CHNO,47 FSET,2
1 CHNO,48 FSET,2
1 CHNO,49 FSET,2
1 CHNO,50 FSET,2
1 CHNO,151 LWLM,0 NAME,PI
1 CHNO,152 LWLM,0 NAME,HI
1 CHNO,153
1 CHNO,154
1 CHNO,155 LWLM,0
1 CHNO,156
1 CHNO,157
1 CHNO,158
1 CHNO,159
1 CHNO,160
1 CHNO,161
1 CHNO,162
1 CHNO,163
```

```
1 CHNO,104
1 CHNO,105 NAME,DVM
1 CHNO,106 NAME,CONFIG
1 CHNO,107
1 CHNO,108
1 CHNO,109
1 CHNO,170
3 AVG,65
3 PSSR,1.0
6 TIME,.1
1 CHNO,25 NAME,S5
1 CHNO,26 NAME,S6
1 CHNO,21 PVID,1
1 CHNO,22 PVID,2
1 CHNO,23 PVID,3
1 CHNO,24 PVID,4
1 CHNO,25 PVID,5
1 CHNO,26 PVID,6
5 ILOC,PROD CON(9,16)
5 IL[illegible],RMOD CON(17,20)
5 ILOC,HIRF CON(25,28)
5 ILOC,LOAD CON(29,36)
5 ILOC,CON8  CON(37,40)
5 ILOC,NEWC CON(41,44)
5 ILOC,C10 CON(45,48)
1 CHNO,21 UPLM,29.0 LWLM,-29.0
1 CHNO,22 UPLM,29.0 LWLM,-30.0
1 CHNO,23 UPLM,22.0 LWLM,-22.0
1 CHNO,24 UPLM,23.0 LWLM,-23.0
1 CHNO,25 UPLM,23.0 LWLM,-38.0
1 CHNO,26 UPLM,27.0 LWLM,[illegible]
1 CHNO,46 UPLM,6.025 LW[illegible]75
1 CHNO,45 UPLM,6.025 LWL[illegible]75
1 CHNO,45 UPLM,6.025 LWLM,[illegible]
1 CHNO,211
1 CHNO,212
1 CHNO,213
1 CHNO,214
1 CHNO,215
```

```
1 CHNO.216
1 CHNO.217
1 CHNO.218
2 SCOD.0
3 FORMAT.6
6 FRM.1
9 END
!EOD
*SAMPLE DECK SETUP FOR A PRESSURE MODEL
*
*
*      NOTE THAT THE MAXIMUM PORT NUMBER IS SET TO 32
*
*      ENGINEERING UNIT EQUATIONS
*
NEU 20
*
*OUTPUT   INPUT1    INPUT2    EQU.TYPE++ZERO      SLOPE      INTERCEPT REFERENCE
*EUNAME   NAME      NAME      CODE++++++CODE      VALUE      VALUE     NAME
*
VG21 A46 R21 LINO 1. 0. ZERO
VG23 A46 R23 LINO 1. 0. ZERO
TOW1 A35 ONE LINO 2.307236059 462.1082617 ZERO
TOW2 A46 ONE LINO 2.303610167 462.2167034 ZERO
TOUW TOW2 ONE LINO 1. 0. ZERO
TT A36 ONE LINO 35.211 491.688 ZERO
TT2 A13 ONE LINO 35.211 491.68  ZERO
TOWF TOW1 ONE LINO 1. 0. R459
TTF TT ONE LINO 1. 0. R459
PI U151 ONE LINO .070727 0. ZERO
HI U152 ONE LINO .070727 0. HIRF
PIHI PI HI LINO 1. 0. ZERO
P100 S100 VG21 LIPO  34.8067 0. PI
P200 S200 VG21 LIPO  33.8965 0. PI
P300 S300 VG23 LIPO  33.4249 0. PI
P400 S400 VG23 LIPO  31.3958 0. PI
P500 S500 VG23 LIPO  23.9929 0. PI
P600 S600 VG23 LIPO  28.1600 0. PI
*MODEL KEARFOTT ONLY. SET ON RANGE 60 ON CONTROL BOX
```

```
THEN A33 ONE ASIN .31669869 .3605 ZERO
THE  THEO ONE LINO 1. 0. ZERO
ENDO
*
*****
*      START OF NBAL LOOP
*
*
*      EXTRA EQUATIONS BEFORE FORCE
*
NEXO 0
ENDO
*
*NOTE NBAL IS 1 EVEN THOUGH THERE IS NO BALANCE TO OBTAIN OTHER COMPUTATIONS
*WHICH OCCUR WITHIN THE NBAL LOOP
*
NBAL 1
*
*      FORCE INPUT
*
*
*      DEFINE BALANCE ATTITUDE
*
*ROTATIONS FROM GRAVITY TO BALANCE
NGB 2
PMOD PITCH
THET  PITCH
*
*      DEFINE MODEL ATTITUDE
*
*ROTATIONS FROM BALANCE TO MODEL
NBM 0
*
*      DEFINE DEFLECTION CONSTANTS
*
*BALANCE AND STING DEFLECTIONS
D SFDF 0
D YMDF 0
D NFDF 0
```

C-3


```
D PMDF 0
D RMDF 0
*
ENDF
*
*      DEFINE MODEL REFERENCE DIMENSIONS
*
D S .049087
D CBAR 20.
D B 3.
*
*      DEFINE BLOCKAGE AND JET BOUNDARY CORRECTIONS
*
D BLK 1
D KBI 0
D KWI .000132649
D J1 0.
D J2 .00549
D J3 0.
*
*      DEFINE BASE PRESSURES
*
NBAS 0
*
*      DEFINE CHAMBER PRESSURES
*
NCBR 0
*
*      DEFINE PRESSURE COEFFICIENT ARRAYS
*
NCP 6
C101 P101 32
C201 P201 32
C301 P301 32
C401 P401 32
C501 P501 32
C601 P601 32
*
*      DEFINE PRESSURE RATIO ARRAYS
```

```
*
NRTO 0
*
*       DEFINE FLOW METERS
*
NFLO 0
*
*
*       EXTRA EQUATIONS AFTER FORCE
*
NEXF 0
ENDX
*
*       DEFINE DISPLAY THUMBWHEELS
*
NDSP 21
VINF 700 RHO 701 RH 702 TDWF 735 TTF 736
PIND 430 RIND 431 ALPW 433 BETA 434 ALPG 335 PHIG 336
TDEW 435 TT 436 REYN 801 TDWF 835 TTF 836 PI 851 HI 852 MACH 853 QINF 854 P  855
ENDD
*
*       POINT-BY-POINT LINE PRINTER OUTPUT
*
NPG 39
PG00 ALPW BETA PIND RIND
PG00 MACH 10.3 QINF 10.3 PI 10.3 HI 10.3 PI 10.3 TT 10.1 TDEW 10.1 D151 10.0
D152 10.0
PG00 S100 S200 S300 S400 S500 S600
PG05 S301 P301 C301 T1 XL1
PG06 S101 P101 C101 T6 XL1
PG05 S306 P306 C306 T12 XL1
PG05 S401 P401 C401 T1 XL2
PG06 S201 P201 C201 T6 XL2
PG05 S406 P406 C406 T12 XL2
PG05 S501 P501 C501 T1 XL3
PG06 S107 P107 C107 T6 XL3
PG05 S506 P506 C506 T12 XL3
PG05 S601 P601 C601 T1 XL4
PG06 S207 P207 C207 T6 XL4
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PG05 S606 P606 C606 T12 XL4
PG06 S311 P311 C311 T1 XL5
PG05 S113 P113 C113 T7 XL5
PG05 S317 P317 C317 T12 XL5
PG06 S411 P411 C411 T1 XL6
PG05 S213 P213 C213 T7 XL6
PG05 S417 P417 C417 T12 XL6
PG06 S511 P511 C511 T1 XL7
PG05 S118 P118 C118 T7 XL7
PG05 S517 P517 C517 T12 XL7
PG06 S611 P611 C611 T1 XL8
PG05 S218 P218 C218 T7 XL8
PG05 S617 P617 C617 T12 XL8
PG06 S322 P322 C322 T1 XL9
PG05 S123 P123 C123 T7 XL9
PG05 S328 P328 C328 T12 XL9
PG06 S422 P422 C422 T1 XL10
PG05 S223 P223 C223 T7 XL10
PG05 S428 P428 C428 T12 XL10
PG06 S522 P522 C522 T1 XL11
PG05 S128 P128 C128 T7 XL11
PG05 S528 P528 C528 T12 XL11
PG06 S622 P622 C622 T1 XL12
PG05 S228 P228 C228 T7 XL12
PG05 S628 P628 C628 T12 XL12
ENDP
*
*      SUMMARY LINE PRINTER OUTPUT
*
NGP 1
GP12 ID 4.0 TP 7.0 MACH  6.3 QINF 10.3 ALPW BETA S100 S200 S300 S400 S500 S600
ENDG
*
*      REORDER HOOKUP FOR PLOTTING
*
NHUK 48
*DATA FOR FIRST PLOT QUADRANT
C301 C401 C501 C601 C311 C411 C511 C611 C322 C422 C522 C622
*DATA FOR SECOND PLOT QUADRANT
```

```
C305 C405 C505 C605 C315 C415 C515 C615 C326 C426 C526 C626
*DATA FOR THIRD PLOT QUADRANT
C104 C204 C110 C210 C115 C215 C120 C220 C125 C225 C130 C230
*DATA FOR FOURTH PLOT QUADRANT
C307 C407 C507 C607 C318 C418 C518 C618 C329 C429 C529 C629
ENDH
*
*     POINT-BY-POINT PLOT OUTPUT
*
NPLT 4
X01 0. .2 X/L C301 -2. 1. C000 12 1
X01 0. .2 X/L C305 -2. 1. C090 12 4
X01 0. .2 X/L C104 -2. 1. C180 12 5
X01 0. .2 X/L C307 -2. 1. C270 12 3
ENDT
*
*     ADDITIONAL POINT-BY-POINT PRESSURE PLOTS
*
MPLT 0
ENDM
*
*     SUMMARY PLOTS
*
SPLT 0
ENDS
*
*****
*
*     END OF NBAL LOOP
*
*
*     ASSORTED CONSTANTS
*
D ZERO 0.0
D ONE 1.0
D R21 5.9983
D R23 5.9983
D R32 29.8241
D R33 29.9489
```

```
D REFL 1.6666
D R459 -459.688
D ALPU 0.0
D JETX 0 UNEK 0 GRID 1
*
*     INFORMATION AFTER SOUT IS RETAINED IN THE DATA BASE
*
SOUT
*
*     THETA AND X/L LOCATIONS OF THE ORIFICES FOR USE WITH PLOTTING AND PRINTING
*
D T1 0. T2 22.5 T3 45. T4 67.5 T5 90. T6 112.5 T7 135. T8 157.5 T9 180.
D T10 202.5 T11 225. T12 247.5 T13 270. T14 292.5 T15 315. T16 337.5
*
D XL1 .075 XA .075 XB .075 XC .075 XD .075 XE .075
D XL2 .125 XF .125 XG .125 XH .125 XI .125 XJ .125
D XL3 .225 XK .225 XL .225 XM .225 XN .225 XO .225
D XL4 .325 XP .325 XQ .325 XR .325 XS .325 XT .325
D XL5 .425 XU .425 XV .425 XW .425 XX .425 XY .425
D XL6 .475 XZ .475 X1 .475 X2 .475 X3 .475 X4 .475
D XL7 .575 X5 .575 X6 .575 X7 .575 X8 .575 X9 .575
D XL8 .675 LA .675 LB .675 LC .675 LD .675 LE .675
D XL9 .775 LF .775 LG .775 LH .775 LI .775 LJ .775
D XL10 .875 LK .875 LL .875 LM .875 LN .875 LO .875
D XL11 .925 LP .925 LQ .925 LR .925 LS .925 LT .925
D XL12 .975 LU .975 LV .975 LW .975  X .975 LY .975
*
D XQ1 .075 XQ1A .125 XQ1B .225 XQ1C .325 XQ1D .425 XQ1E .475 XQUF .575 XQ1G .675
D XQ1H .775 XQ1I .875 XQ1J .925 XQ1K .975
*
!EOD
```

The following is an RTAT setup deck for a single balance force model test.

```
!JOB  OAP-7 PLUS RTAT-4.4     SAMPLE DECK SETUP FOR A SINGLE BALANCE FORCE MODEL
!PAUSE KEYIN FG,S        MOUNT RAW DATA TAPE ON M9
!REWIND M9
!ASSIGN UD=GX,F
!ASSIGN F:500=F500,UD,F
!ASSIGN F:501=F501,UD,F
!ASSIGN F:502=F502,UD,F
!ASSIGN F:503=F503,UD,F
!ASSIGN F:504=F504,UD,F
!ASSIGN F:505=F505,UD,F
!ASSIGN F:511=F511,UD,F
!ASSIGN F:106=LP,F
!ASSIGN F:11=M3,F
!ASSIGN F:11=0,F
!ASSIGN M1=M9,F
!ASSIGN M2=M9,F
!ASSIGN F:101=CVALUE,UD,F
!ASSIGN F:102=CNAME,UD,F
!ASSIGN F:103=TARES,UD,F
!ASSIGN F:104=CALMV,UD,F
!ASSIGN F:108=CALSCR,UD,F
!ASSIGN F:107=CALDATA,FD,F
!ASSIGN F:120=CDATA,UD,F
!ASSIGN F:121=SYSCAL,UD,F
!ASSIGN F:122=CBAL,UD,F
!ASSIGN F:100=OAP,UP,F
!ASSIGN CL=CALDATA,FD,F
!ASSIGN L1=OAP,UP,F
!ASSIGN F:1=GX,F
!ASSIGN F:600=F600,UD,F
!ASSIGN F:601=F601,UD,F
!ASSIGN F:602=F602,UD,F
!ASSIGN F:603=F603,UD,F
!ASSIGN F:604=F604,UD,F
!ASSIGN F:605=F605,UD,F
!ASSIGN F:611=F611,UD,F
!ASSIGN F:123=SNAME,UD,F
```

```
!ASSIGN F:124=CCOM,UD,F
!ASSIGN F:301=CVALU2,UD,F
!ASSIGN F:302=CNAME2,UD,F
!ASSIGN F:303=TARES2,UD,F
!ASSIGN F:304=CALMV2,UD,F
!ASSIGN F:321=SYSCA2,UD,F
!ASSIGN F:323=SNAME2,UD,F
!ASSIGN F:324=CCOM2,UD,F
!ASSIGN F:125=KNAME,UD,F
!ASSIGN F:325=KNAME2,UD,F
!ASSIGN F:126=A0,F
!ASSIGN F:127=B0,F
!ASSIGN F:2=GX,F
!OAP
9END
!EOD
1 CHNO,1 FSET,1 NAME,NF
1 CHNO,2 FSET,1 NAME,AF
1 CHNO,3 FSET,1 NAME,PM
1 CHNO,4 FSET,1 NAME,RM
1 CHNO,5 FSET,1 NAME,YM
1 CHNO,6 FSET,1 NAME,SF
1 CHNO,7 FSET,2 OFST,0.0 NAME,PC1
1 CHNO,8 FSET,2 OFST,0.0
1 CHNO,9 FSET,2 OFST,0.0
1 CHNO,10 FSET,2 OFST,0.0
1 CHNO,11 FSET,2 OFST,0.0
1 CHNO,12 FSET,2 OFST,0.0
1 CHNO,13 FSET,2 OFST,0.0
1 CHNO,14 FSET,2
1 CHNO,15 FSET,1
1 CHNO,16 FSET,1
1 CHNO,17 FSET,1
1 CHNO,18 FSET,1
1 CHNO,19 FSET,1
1 CHNO,20 FSET,1
1 CHNO,21 FSET,2 OFST,0.0 NAME,S1
1 CHNO,22 FSET,2 OFST,0.0 NAME,S2
1 CHNO,23 FSET,2 OFST,0.0 NAME,S3
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
1 CHNO.24 FSET.2 OFST.0.0 NAME.S4
1 CHNO.25 FSET.2
1 CHNO.26 FSET.2
1 CHNO.27 FSET.2
1 CHNO.28 FSET.2
1 CHNO.29 FSET.2
1 CHNO.30 FSET.1
1 CHNO.31 FSET.1
1 CHNO.32 FSET.1
1 CHNO.33 FSET.1 OFST.0.0 NAME.PIND
1 CHNO.34 FSET.1 OFST.0.0
1 CHNO.35 FSET.2 OFST.0.0 NAME.TDEW
1 CHNO.36 FSET.2 OFST.0.0 NAME.TT
1 CHNO.37 FSET.2 OFST.0.0
1 CHNO.38 FSET.2 OFST.0.0
1 CHNO.39 FSET.2 OFST.0.0
1 CHNO.40 FSET.2
1 CHNO.41 FSET.2 OFST.0.0 NAME.G1
1 CHNO.42 FSET.2 OFST.0.0 NAME.G2
1 CHNO.43 FSET.2 OFST.0.0 NAME.G3
1 CHNO.44 FSET.2 OFST.0.0 NAME.G4
1 CHNO.45 FSET.2 OFST.0.0 NAME.G5
1 CHNO.46 FSET.2 OFST.0.0 NAME.G6
1 CHNO.47 FSET.2
1 CHNO.48 FSET.2
1 CHNO.49 FSET.2
1 CHNO.50 FSET.2
1 CHNO.151 LWLM.0 NAME.PI
1 CHNO.152 LWLM.0 NAME.HI
1 CHNO.153
1 CHNO.154
1 CHNO.155 LWLM.0
1 CHNO.156
1 CHNO.157
1 CHNO.158
1 CHNO.159
1 CHNO.160
1 CHNO.161
1 CHNO.162
```

```
1 CHNO.163
1 CHNO.164
1 CHNO.165 NAME.DVM
1 CHNO.166 NAME.CONFIG
1 CHNO.167
1 CHNO.168
1 CHNO.169
1 CHNO.170
3 AVG.65
3 PSSR.1.0
6 TIME..1
1 CHNO.25 NAME.S5
1 CHNO.26 NAME.S6
5 ILOC.PMOD CON(9.16)
5 ILOC.RMOD CON(17.24)
5 ILOC.HIRF CON(25.28)
5 ILOC.LOAD CON(29.36)
5 ILOC.YAWK CON(29.36)
5 ILOC.CONB  CON(37.40)
5 ILOC.NEWC CON(41.44)
5 ILOC.C10 CON(45.48)
1 CHNO.211
1 CHNO.212
1 CHNO.213
1 CHNO.214
1 CHNO.215
1 CHNO.216
1 CHNO.217
1 CHNO.218
2 SCOD.0
6 FRM.1
1 CHNO.1 UPLM.7.5912 LWLM.-9.6052
1 CHNO.2 UPLM.6.2663 LWLM.-5.0003
1 CHNO.3 UPLM.6.5364 LWLM.-6.90835
1 CHNO.4 UPLM.7.0455 LWLM.-8.0575
1 CHNO.5 UPLM.6.16944 LWLM.-5.66144
1 CHNO.6 UPLM.5.70913 LWLM.-4.25913
1 CHNO.26 UPLM.32.0 LWLM.28.0
1 CHNO.41 UPLM.5.025 LWLM.4.975
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```
1 CHNO.43 UPLM.6.025 LWLM.5.975
9 END
IEOD
*SAMPLE DECK SETUP FOR A SINGLE BALANCE FORCE MODEL
*
*     ENGINEERING UNIT EQUATIONS
*
NEU 24
*
*OUTPUT  INPUT1     INPUT2     EQU.TYPE**ZERO      SLOPE      INTERCEPT REFERENCE
*EUNAME  NAME       NAME       CODE******CODE      VALUE      VALUE     NAME
*
VG1 A41 R1 LINO 1. 0. ZERO
VG7 A43 R7 LINO 1. 0. ZERO
NF A1 VG1 LIYE 186.08572 0. ZERO
AF A2 VG1 LIYE 13.31359 0. ZERO
PM A3 VG1 LIYE 446.27222 0. ZERO
RM A4 VG1 LIYE 198.63626 0. ZERO
YM A5 VG1 LIYE 253.14583 0. ZERO
SF A6 VG1 LIYE 100.51839 0. ZERO
TDW1 A35 ONE LINO 2.307236059 462.1082617 ZERO
TDW2 A40 ONE LINO 2.303610167 462.2167034 ZERO
*TDEW TDW1 ONE LINO 1. 0. ZERO
TDEW TDW2 ONE LINO 1. 0. ZERO
TT A36 ONE LINO 35.211 491.688 ZERO
TT2 A13 ONE LINO 35.211 491.688 ZERO
TDWF TDW1 ONE LINO 1. 0. R459
TTF TT ONE LINO 1. 0. R459
PI D151 ONE LINO .070727 0. ZERO
HI D152 ONE LINO .070727 0. HIRF
P7 A7 VG7 LIYE 10.0200 0. PI
P8 A8 VG7 LIYE 15.1516 0. PI
P9 A9 VG7 LIYE 11.5566 0. PI
P10 A10 VG7 LIYE 14.8576 0. PI
THES A32 ONE ASIN .00472409 -1.3330 ZERO
THEM A33 ONE ASIN .00706499 -.1402 ZERO
PIND THES ONE LINO 1. 0. ZERO
ENDO
*
```

```
*****
*
*      START OF NBAL LOOP
*
*
*      EXTRA EQUATIONS BEFORE FORCE
*
NEXU 0
ENDU
*
NBAL 1
*
*      FORCE INPUT
*
*
*      DEFINE BALANCE TO OBTAIN CALIBRATION DECK FROM BALANCE HISTORY FILE
*
*NOTE THE FIRST FIELD IS TRUNCATED TO THE KEYWORD BALA
*
BALANCE $842-BS $11-1-77$
*
*      DEFINE BALANCE ATTITUDE
*
*ROTATIONS FROM GRAVITY TO BALANCE
NGB 7
PIND PITCH
YAWK YAW
PMOD PITCH
RMOD ROLL
YAWS YAW
ALPS PITCH
PHIS ROLL
*
*      DEFINE MODEL ATTITUDE
*
*ROTATIONS FROM BALANCE TO MODEL
NBM 1
THEA PITCH
*
```

```
*     DEFINE DEFLECTION CONSTANTS
*
D NFDF .0027710
D PMDF .00040464
D SFDF .0028399
D YMDF .00045630
D RMDF .00057096
*
*     DEFINE MOMENT TRANSFER DISTANCES
*
D XBAR 1.594 YBAR 0. ZBAR .23
*
ENDF
*
*     DEFINE MODEL REFERENCE DIMENSIONS
*
D S 2.667 CBAR 22.385 B 23.446
*
*     DEFINE BLOCKAGE AND JET BOUNDARY CORRECTIONS
*
BLK 1
*
D KWI .000383
D KBI .0004250
D J2 .288261
D J3 0.0.09
D KJ .000024
*
*BASE PRESSURE CORRECTIONS
*
NBAS 0
*
*CHAMBER PRESSURE CORRECTIONS
*
NCBR 4
*OUTPUT INPUT AREAS    AREAS*ARMS  FLAG
*NAME   NAME  AF SF NF RM PM YM
CPC1 P7 .010455 0 0 0 0 0 1.
CPC2 P8 0 0 0 0 0 0.
```

```
CPC3 P9   0 0 0 0 0 0.
CPC4 P10 .010455 0 0 0 0 0 1.
*
*      DEFINE PRESSURE COEFFICIENT ARRAYS
*
NCP 0
*
*      DEFINE PRESSURE RATIO ARRAYS
*
NRTO 0
*
*      DEFINE FLOW METERS
*
NFLO 0
*
*
*      EXTRA EQUATIONS AFTER FORCE
*
NEXF 2
*COMPUTE A DRAG COEFFICIENT CORRECTION AS A FUNCTION OF MACH AND ALPW
TAB2 CDI ALPW MACH 10. 4.
0.0          .2          .6          .8          .9
-6.          .0018       .00176      .00165      .00143
-4.          .0017       .0016       .001405     .0013
0.           .001575     .0014       .0013       .00112
5.           .001625     .0015       .001325     .0012
10.          .00185      .00175      .001595     .00145
15.          .00215      .00205      .001925     .0018
20.          .00255      .002425     .0023       .00221
25.          .0031       .002975     .00289      .0028
30.          .003935     .003705     .00358      .00339
34.          .0048       .00435      .0041       .00386
*COMPUTE A TOTAL DRAG COEFFICIENT BY CORRECTING THE MODEL DRAG COEFFICIENT
VSV CDT CD CDI 1
ENDX
*
*      DEFINE DISPLAY THUMBWHEELS
*
NDSP 39
```

```
VINF 700 RHO 701 RH 702 TDWF 735 TTF 736
NF 301 AF 302 PM 303 RM 304 YM 305 SF 306 P7 307 P8 308 P9 309 P10 310
CL 401 CD 402 CMS 403 CRMS 404 CYMS 405 CYS 406
CDI 501 CDT 502  L/D 503
PIND 430          ALPW 432 BETA 434 ALPG 335 PHIG 336
TDEW 435 TT 436 REYN 801 TDWF 835 TTF 836 PI 851 HI 852 MACH 853 QINF 854 P1 855
ENDD
*
*     POINT-BY-POINT LINE PRINTER OUTPUT
*
NPG 12
PG00 ALPW BETA MACH 10.3 QINF 10.3 PIND 12.6     D161 10.0 D162 10.0
PG00 PI 10.3 HI 10.3 P1 10.3 TT 10.1 TDEW 10.1 TT2 10.1 TDW2 10.1
PG00 NF AF PM RM YM SF
PG00 NFC AFC PMC RMC YMC SFC           CPC1 CPC2  CPC3 CPC4
PG00 NFTA AFTA PMTA RMTA YMTA SFTA     AFB XAFB
PG00 NFBA AFBA PMBA RMBA YMBA SFBA     AFCH XAFC
PG00 NFTO AFTO PMTO RMTO YMTO SFTO
PG00 NFMA AFMA PMMA RMMA YMMA SFMA
PG00 CN CA CM CRM CYM CY     DELA DELM
PG00 CDI CDT P7 10.3 P8 10.3 P9 10.3 P10 10.3
PG00 CL CD CMS CRMS CYMS CYS L/D 12.5
PG00      ALPZ PHIZ ALPS PHIS YAWS ALPG PHIG YAWG
ENDP
*
*     SUMMARY LINE PRINTER OUTPUT
*
NGP 3
GP12 ID 4.0 TP 7.0 MACH  6.3 QINF 10.3 ALPW BETA CL CD CMS CRMS CYMS CYS
GP11 ID 4.0 TP 7.0 MACH  6.3 QINF 10.3 ALPW BETA CDI CD CDT CL L/D
GP10 ID 4.0 TP 7.0 MACH  6.3 QINF 10.3 ALPW BETA CPC1 CPC2 CPC3 CPC4
ENDG
*
*     REORDER HOOKUP FOR PLOTTING
*
NHUK 0
ENDH
*
*     POINT-BY-POINT PLOT OUTPUT
```

```
*
NPLT 4
CL -.5 .5 CL ALPW -10. 10. ALPW 1 1
CL -.5 .5 CL CDT 0. .2 CDT 1 2
CL -.5 .5 CL CMS -.3 .1 CMS 1 3
CL -.5 .5 CL L/D -2. 2. L/D 1 4
ENDT
*
*     ADDITIONAL POINT-BY-POINT PRESSURE PLOTS
*
MPLT 0
ENDM
*
*     SUMMARY PLOTS
*
SPLT 4
ALPW -10. 10. ALPW CPC1 -.06 .02 CPC1 1 1
ALPW -10. 10. ALPW CPC2 -.06 .02 CPC2 1 4
ALPW -10. 10. ALPW CPC3 -.06 .02 CPC3 1 6
ALPW -10. 10. ALPW CPC4 -.06 .02 CPC4 1 3
ENDS
*
*****
*
*     END OF NBAL LOOP
*
*
*     ASSORTED CONSTANTS
*
D ZERO 0.0
D ONE 1.0
D R0 1.
D R1 5.
D R7 5.9776
D R459 -459.688
D REFL 1.8654
D ALPU 0.0
D XFLO 0.
D KDFL DELTA
```

```
D JETX 0 UNEK 0 GRID 1
*
*     INFORMATION AFTER SCUT IS RETAINED IN THE DATA BASE
*
SOUT
*
D THEA 1.00000
D KJ .00+024
!EOD
```

The following is an RTAT setup deck for a dual balance force model test.

```
!JOB  OAP-7 PLUS RTAT-4.4     SAMPLE DECK SETUP FOR A TWO BALANCE FORCE MODEL
!PAUSE KEYIN FG,S        MOUNT RAW DATA TAPE ON M9
!REWIND M9
!ASSIGN GO=GX,F
!ASSIGN F:500=F500,UD,F
!ASSIGN F:501=F501,UD,F
!ASSIGN F:502=F502,UD,F
!ASSIGN F:503=F503,UD,F
!ASSIGN F:504=F504,UD,F
!ASSIGN F:505=F505,UD,F
!ASSIGN F:511=F511,UD,F
!ASSIGN F:106=LP,F
!ASSIGN F:11=M3,F
!ASSIGN F:11=0,F
!ASSIGN M1=M9,F
!ASSIGN M2=M9,F
!ASSIGN F:101=CVALUE,UD,F
!ASSIGN F:102=CNAME,UD,F
!ASSIGN F:103=TARES,UD,F
!ASSIGN F:104=CALMV,UD,F
!ASSIGN F:108=CALSCR,UD,F
!ASSIGN F:107=CALDATA,FD,F
!ASSIGN F:120=CDATA,UD,F
!ASSIGN F:121=SYSCAL,UD,F
!ASSIGN F:122=CBAL,UD,F
!ASSIGN F:100=OAP,UP,F
!ASSIGN CL=CALDATA,FD,F
!ASSIGN L1=OAP,UP,F
!ASSIGN F:1=GX,F
!ASSIGN F:600=F600,UD,F
!ASSIGN F:601=F601,UD,F
!ASSIGN F:602=F602,UD,F
!ASSIGN F:603=F603,UD,F
!ASSIGN F:604=F604,UD,F
!ASSIGN F:605=F605,UD,F
!ASSIGN F:611=F611,UD,F
!ASSIGN F:123=SNAME,UD,F
```

```
!ASSIGN F:124=CCOM,UD,F
!ASSIGN F:301=CVALU2,UD,F
!ASSIGN F:302=CNAME2,UD,F
!ASSIGN F:303=TARES2,UD,F
!ASSIGN F:304=CALMV2,UD,F
!ASSIGN F:321=SYSCA2,UD,F
!ASSIGN F:323=SNAME2,UD,F
!ASSIGN F:324=CCOM2,UD,F
!ASSIGN F:125=KNAME,UD,F
!ASSIGN F:325=KNAME2,UD,F
!ASSIGN F:126=A0,F
!ASSIGN F:127=B0,F
!ASSIGN F:2=GX,F
!OAP
9END
!EOD
1 CHNO,1 FSET,1 NAME,NF
1 CHNO,2 FSET,1 NAME,AF
1 CHNO,3 FSET,1 NAME,PM
1 CHNO,4 FSET,1 NAME,RM
1 CHNO,5 FSET,1 NAME,YM
1 CHNO,6 FSET,1 NAME,SF
1 CHNO,7 FSET,2 OFST,0.0 NAME,PC1
1 CHNO,8 FSET,2 OFST,0.0
1 CHNO,9 FSET,2 OFST,0.0
1 CHNO,10 FSET,2 OFST,0.0
1 CHNO,11 FSET,2 OFST,0.0
1 CHNO,12 FSET,2 OFST,0.0
1 CHNO,13 FSET,2 OFST,0.0
1 CHNO,14 FSET,2
1 CHNO,15 FSET,1
1 CHNO,16 FSET,1
1 CHNO,17 FSET,1
1 CHNO,18 FSET,1
1 CHNO,19 FSET,1
1 CHNO,20 FSET,1
1 CHNO,21 FSET,2 OFST,0.0 NAME,S1
1 CHNO,22 FSET,2 OFST,0.0 NAME,S2
1 CHNO,23 FSET,2 OFST,0.0 NAME,S3
```

```
1 CHNO,24 FSET,2 OFST,0.0 NAME,S4
1 CHNO,25 FSET,2
1 CHNO,26 FSET,2
1 CHNO,27 FSET,2
1 CHNO,28 FSET,2
1 CHNO,29 FSET,2
1 CHNO,30 FSET,1
1 CHNO,31 FSET,1
1 CHNO,32 FSET,1
1 CHNO,33 FSET,1 OFST,0.0 NAME,PIND
1 CHNO,34 FSET,1 OFST,0.0
1 CHNO,35 FSET,2 OFST,0.0 NAME,TDEW
1 CHNO,36 FSET,2 OFST,0.0 NAME,TT
1 CHNO,37 FSET,2 OFST,0.0
1 CHNO,38 FSET,2 OFST,0.0
1 CHNO,39 FSET,2 OFST,0.0
1 CHNO,40 FSET,2
1 CHNO,41 FSET,2 OFST,0.0 NAME,G1
1 CHNO,42 FSET,2 OFST,0.0 NAME,G2
1 CHNO,43 FSET,2 OFST,0.0 NAME,G3
1 CHNO,44 FSET,2 OFST,0.0 NAME,G4
1 CHNO,45 FSET,2 OFST,0.0 NAME,G5
1 CHNO,46 FSET,2 OFST,0.0 NAME,G6
1 CHNO,47 FSET,2
1 CHNO,48 FSET,2
1 CHNO,49 FSET,2
1 CHNO,50 FSET,2
1 CHNO,151 LWLM,0 NAME,PI
1 CHNO,152 LWLM,0 NAME,HI
1 CHNO,153
1 CHNO,154
1 CHNO,155 LWLM,0
1 CHNO,156
1 CHNO,157
1 CHNO,158
1 CHNO,159
1 CHNO,160
1 CHNO,161
1 CHNO,162
```

```
1 CHNO,163
1 CHNO,164
1 CHNO,165 NAME,DVM
1 CHNO,166 NAME,CONFIG
1 CHNO,167
1 CHNO,168
1 CHNO,169
1 CHNO,170
3 AVG,65
3 PSSR,1.0
6 TIME,.1
1 CHNO,25 NAME,S5
1 CHNO,26 NAME,S6
5 ILOC,PMOD CON(9,16)
5 ILOC,RMOD CON(17,24)
5 ILOC,HIRF CON(25,26)
5 ILOC,LOAD CON(29,36)
5 ILOC,CON8  CON(37,40)
5 ILOC,NEWC CON(41,44)
5 ILOC,C10 CON(45,48)
1 CHNO,211
1 CHNO,212
1 CHNO,213
1 CHNO,214
1 CHNO,215
1 CHNO,216
1 CHNO,217
1 CHNO,218
1 CHNO,1 UPLM,8.21361 LWLM,-7.2300
1 CHNO,2 UPLM,5.69174 LWLM,-4.59434
1 CHNO,3 UPLM,3.88774 LWLM,-7.33294
1 CHNO,4 UPLM,4.62182 LWLM,-4.63780
1 CHNO,5 UPLM,5.08552 LWLM,-4.93600
1 CHNO,6 UPLM,6.10498 LWLM,-4.09272
1 CHNO,15 UPLM,4.45202 LWLM,-4.32206
1 CHNO,16 UPLM,5.62103 LWLM,-9.94092
1 CHNO,17 UPLM,4.13406 LWLM,-7.38542
1 CHNO,18 UPLM,3.48723 LWLM,-7.32011
1 CHNO,19 UPLM,7.16094 LWLM,-2.61480
```

```
1 CHNO.20 UPLM.5.01157 LWLM.-5.89900
1 CHNO.41 UPLM.5.025 LWLM.4.975
1 CHNO.42 UPLM.5.025 LWLM.4.975
1 CHNO.43 UPLM.6.025 LWLM.5.975
2 SCOD.0
6 FRM.1
9 END
!EOD
*SAMPLE DECK SETUP FOR A TWO BALANCE FORCE MODEL
*
*     ENGINEERING UNIT EQUATIONS FOR BOTH BALANCES
*
NEU 31
*
*OUTPUT  INPUT1    INPUT2    EQU.TYPE++ZERO     SLOPE     INTERCEPT REFERENCE
*EUNAME  NAME      NAME      CODE++++++CODE     VALUE     VALUE     NAME
*
VG1 A41 R1 LINO 1. 0. ZERO
VG2 A42 R2 LINO 1. 0. ZERO
VG7 A43 R7 LINO 1. 0. ZERO
NF A1 VG1 LIYE 155.29259 0. ZERO
AF A2 VG1 LIYE 24.27863 0. ZERO
PM A3 VG1 LIYE 356.18799 0. ZERO
RM A4 VG1 LIYE 215.82684 0. ZERO
YM A5 VG1 LIYE 398.61816 0. ZERO
SF A6 VG1 LIYE 97.999977 0. ZERO
NF2 A15 VG2 LIYE 68.28798 0. ZERO
AF2 A16 VG2 LIYE 7.69769 0. ZERO
PM2 A17 VG2 LIYE 173.36761 0. ZERO
RM2 A18 VG2 LIYE 18.47078 0. ZERO
YM2 A19 VG2 LIYE 81.74535 0. ZERO
SF2 A20 VG2 LIYE 36.59914 0. ZERO
TOW1 A35 ONE LINO 2.307236059 462.1082617 ZERO
TOW2 A40 ONE LINO 2.303610167 462.2167034 ZERO
*TDEW TOW1 ONE LINO 1. 0. ZERO
TDEW TOW2 ONE LINO 1. 0. ZERO
TT A36 ONE LINO 35.211 491.688 ZERO
TT2 A13 ONE LINO 35.211 491.688 ZERO
TOWF TOW1 ONE LINO 1. 0. R459
```

```
TTF TT ONE LINO 1. 0. R459
PI D151 ONE LINO .070727 0. ZERO
HI D152 ONE LINO .070727 0. HIRF
PIHI PI HI LINO 1. 0. ZERO
P7 A7 VG7 LIYE 10.0200 0. PI
P8 A8 VG7 LIYE 15.1516 0. PI
P9 A9 VG7 LIYE 11.5566 0. PI
P10 A10 VG7 LIYE 14.8576 0. PI
PIND A30 ONE LIYE -1.0014 0. ZERO
RIND A31 ONE LIYE 2.9583 0. ZERO
ENDQ
*
*****
*
*      START OF NBAL LOOP
*
*
*      EXTRA EQUATIONS BEFORE FORCE
*
NEXU 0
ENDU
*
NBAL 2
*
*      FORCE INPUT
*
*
*      MAIN BALANCE INPUTS
*
*      DEFINE BALANCE TO OBTAIN CALIBRATION DECK FROM BALANCE HISTORY FILE
*
*NOTE THE FIRST FIELD IS TRUNCATED TO THE KEYWORD BALA
*
BALANCE $739$ $06/07/79$
*
D PHIB 180.
D RMD1 -180.
*
*      DEFINE BALANCE ATTITUDE
```

```
*
*ROTATIONS FROM GRAVITY TO BALANCE
NGB 8
PIND PITCH
PMOD PITCH
RIND ROLL
RMOD ROLL
PHIB ROLL
YAWS YAW
ALPS PITCH
PHIS ROLL
*
*      DEFINE MODEL ATTITUDE
*
*ROTATIONS FROM BALANCE TO MODEL
NBM 1
RMOI ROLL
*
*      DEFINE DEFLECTION CONSTANTS
*
D NFDF .0054293
D PMDF .00057949
D SFDF .0052635
D YMDF .00053005
D RMDF .00095799
*
*      DEFINE MOMENT TRANSFER DISTANCES
*
D XBAR 2.40375
D YBAR 0.
D ZBAR 0.
*
ENDF
*
*      DEFINE MODEL REFERENCE DIMENSIONS
*
D S 1.1109
D CHAR 9.185
D B 20.
```

```
*
*     DEFINE BLOCKAGE AND JET BOUNDARY CORRECTIONS
*
BLK 1
*
D KWI .00009722
D J3 0.
D J2 .1250
D J1 .002105
D KRI .00029604
*
*BASE PRESSURE CORRECTIONS
*
NBAS 1
*OUTPUT INPUT AREAS    AREAS*ARMS  FLAG
*NAME    NAME  AF SF NF RM PM YM
*
CPB1 P10 .0555183 0 0 0 0 0 -1.
*
*CHAMBER PRESSURE CORRECTIONS
*
NCBR 3
*OUTPUT INPUT AREAS    AREAS*ARMS  FLAG
*NAME    NAME  AF SF NF RM PM YM
*
CPC1 P7 .0349605 0 0 0 0 0 1.
CPC2 P8 .0349605 0 0 0 0 0 1.
CPC3 P9 .0144024 0 0 0 0 0 -1.
*
*     DEFINE PRESSURE COEFFICIENT ARRAYS
*
NCP 0
*
*     DEFINE PRESSURE RATIO ARRAYS
*
NRTO 0
*
*     DEFINE FLOW METERS
*
```

```
NFLO 0
*
*****
*
*     EXTRA EQUATIONS AFTER FORCE
*
NEXF 0
ENDX
*
*     DEFINE DISPLAY THUMBWHEELS
*
NDSP 27
VINF 700 RHO 701 RH 702 TDWF 735 TTF 736
NF 301 AF 302 PM 303 RM 304 YM 305 SF 306 P7 307 P8 308 P9 309 P10 310
CL 401 CD 402 CMS 403 CRMS 404 CYMS 405 CYS 406
PIND 430 RIND 431 ALPW 433 BETA 434 ALPG 335 PHIG 336
ENDD
*
*     POINT-BY-POINT LINE PRINTER OUTPUT
*
NPG 11
PG00 ALPW BETA MACH 10.3 QINF 10.3 PIND 12.6 RIND 12.6      BAL1 10.0
PG00 PI 10.3 HI 10.3 P1 10.3 TT 10.1 TDEW 10.1 TT2 10.1 TDW2 10.1
PG00 NF AF PM RM YM SF
PG00 NFC AFC PMC RMC YMC SFC           CPC1 CPC2
PG00 NFTA AFTA PMTA RMTA YMTA SFTA     AFB XAFB
PG00 NFBA AFBA PMBA RMBA YMBA SFBA     AFCH XAFC
PG00 NFTO AFTO PMTO RMTO YMTO SFTO
PG00 NFMA AFMA PMMA RMMA YMMA SFMA
PG00 CN CA CM CRM CYM CY     DELA DELM
PG00 CL CD CMS CRMS CYMS CYS L/D 12.5 P7 10.3 P8 10.3
PG00 RMD1 ALPZ PHIZ ALPS PHIS YAWS ALPG PHIG YAWG
ENDP
*
*     SUMMARY LINE PRINTER OUTPUT
*
NGP 2
GP12 ID 4.0 TP 7.0 MACH  6.3 QINF 10.3 ALPW BETA CL CD CMS CRMS CYMS CYS
GP05 ID 4.0 TP 7.0 CRM CYM CY
```

```
ENDG
*
*      REORDER HOOKUP FOR PLOTTING
*
NHUK 0
ENDH
*
*      POINT-BY-POINT PLOT OUTPUT
*
NPLT 4
ALPW 0. 10. ALPW CL -.4 .4 CL 1. 1.
ALPW 0. 10. ALPW CMS -.8 .4 CMS 1. 4.
ALPW 0. 10. ALPW CD 0. .4 CD 1. 6.
ALPW 0. 10. ALPW CYM -.08 .04 CYM 1. 3.
ENDT
*
*      ADDITIONAL POINT-BY-POINT PRESSURE PLOTS
*
MPLT 0
ENDM
*
*      SUMMARY PLOTS
*
SPLT 0
ENDS
*
*
*
*****
*
*      END OF NBAL LOOP FOR MAIN BALANCE
*
*
*****
*
*      START OF NBAL LOOP
*
*      NOSE BALANCE INPUTS
*
```

```
*
*NOTE THAT ENGINEERING UNITS HAVE ALREADY BEEN SPECIFIED
*
*     EXTRA EQUATIONS BEFORE FORCE
*
NEXU 0
ENDU
*
*     FORCE INPUT
*
*     DEFINE BALANCE TO OBTAIN CALIBRATION DECK FROM BALANCE HISTORY FILE
*
*NOTE THE FIRST FIELD IS TRUNCATED TO THE KEYWORD BALA
*
BALANCE $834$ $11/16/77$
*
D RBL2 0.00
D PBL2 0.00
D RMD2 -180.
*
*     DEFINE BALANCE ATTITUDE
*
*NOTE THAT ROTATIONS START FROM MAIN BALANCE GRAVITY ATTITUDE--YAWG,ALPG,PHIG--
*THAT IS, ACCESSING THE DATA BASE AT THIS POINT WILL RETURN THE MAIN BALANCE
*DATA SINCE THE NOSE BALANCE VALUES HAVE NOT YET BEEN ADDED TO THE DATA BASE
*
*ROTATIONS FROM GRAVITY TO BALANCE
NGB 5
YAWG YAW
ALPG PITCH
PHIG ROLL
PBL2 PITCH
RBL2 ROLL
*
*     DEFINE MODEL ATTITUDE
*
*ROTATIONS FROM BALANCE TO MODEL
NBM 1
RMD2 ROLL
```

```
*
*      DEFINE DEFLECTION CONSTANTS
*
D SFDF 0
D YMDF 0
D NFDF 0
D PMDF 0
D RMDF 0
*
*      DEFINE MOMENT TRANSFER DISTANCES
*
D XBAR -9.02125
D YBAR 0.
D ZBAR 0.
*
ENDF
*
*
*      DEFINE MODEL REFERENCE DIMENSIONS
*
D S 1.1109
D CBAR 9.185
D B 20.
*
*BASE PRESSURE CORRECTIONS
*
NBAS 1
*OUTPUT INPUT AREAS    AREAS*ARMS  FLAG
*NAME   NAME  AF SF NF RM PM YM
*
CPB2 P10 .0555183 0 0 0 0 0  1.
*
*CHAMBER PRESSURE CORRECTIONS
*
NCBR 1
*OUTPUT INPUT AREAS    AREAS*ARMS  FLAG
*NAME   NAME  AF SF NF RM PM YM
*
CPC4 P9 .0144024 0 0 0 0 0  1.
```

```
*
*
*      EXIRA EQUATIONS AFTER FORCE
*
NEXF 0
ENDX
*
*      DEFINE DISPLAY THUMBWHEELS
*
NDSP 26
NF2 501 AF2 502 PM2 503 RM2 504 YM2 505 SF2 506
CL 601 CD 602 CMS 603 CRMS 604 CYMS 605 CYS 606
ALPW 533 BETA 534 ALPG 535 PHIG 536
TDEW 435 TT 436 REYN 801 TDWF 835 TTF 836 PI 851 HI 852 MACH 853 QINF 854 P1 855
ENDD
*
*      POINT-BY-POINT LINE PRINTER OUTPUT
*
NPG 11
PG00 ALPW BETA MACH 10.3 QINF 10.3 PIND 12.6 RAL2 10.0
PG00 PI 10.3 HI 10.3 P1 10.3 TT 10.1 TDEW 10.1 TT2 10.1 TDW2 10.1
PG00 NF2 AF2 PM2 RM2 YM2 SF2
PG00 NFC AFC PMC RMC YMC SFC                 CPB1 CPC3
CPB2 CPC4
PG00 NFTA AFTA PMTA RMTA YMTA SFTA     AFB XAFB
PG00 NFBA AFBA PMBA RMBA YMBA SFBA     AFCH XAFC
PG00 NFTO AFTO PMTO RMTO YMTO SFTO
PG00 NFMA AFMA PMMA RMMA YMMA SFMA
PG00 CN CA CM CRM CYM CY     DELA DELM PBL2 RBL2
PG00 CL CD CMS CRMS CYMS CYS L/D 12.5 P9 10.3 P10 10.3
PG00 RBL2 RMD2 ALPZ PHIZ ALPS PHIS YAWS ALPG PHIG YAWG
ENDP
*
*      SUMMARY LINE PRINTER OUTPUT
*
NGP 2
GP12 ID 4.0 TP 7.0 MACH  6.3 QINF 10.3 ALPW BETA CL CD CMS CRMS CYMS CYS
GP05 ID 4.0 TP 7.0 CRM CYM CY
ENDG
```

```
*
*     REORDER HOOKUP FOR PLOTTING
*
NHUK 0
ENDH
*
*     POINT-BY-POINT PLOT OUTPUT
*
NPLT 0
ENDT
*
*     ADDITIONAL POINT-BY-POINT PRESSURE PLOTS
*
MPLT 0
ENDM
*
*     SUMMARY PLOTS
*
SPLT 4
ALPW 0. 10. ALPW CL -.4 .4 CL 1. 1.
ALPW 0. 10. ALPW CMS -.8 .4 CMS 1. 4.
ALPW 0. 10. ALPW CD 0. .4 CD 1. 6.
ALPW 0. 10. ALPW CYM -.08 .04 CYM 1. 3.
ENDS
*
*****
*
*     END OF NBAL LOOP FOR NOSE BALANCE
*
*     ASSORTED CONSTANTS
*
*
*
*
D ALPU 0.0
D XFLO 0.
*
*     INFORMATION AFTER SOUT IS RETAINED IN THE DATA BASE
*
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
*
SOUT
*
D ZERO 0.0
D ONE 1.0
D R0 1.
D R1 5.000000000
D R2 5.0000000
D R7 5.999
D R459 -459.688
D REFL .7654
*
D KDFL DELTA
D JETX 0
D UNEK 0
D GRID 1
D KJ .004024
D PHIB 180.
D RBL2 0.00
D PBL2 0.00
D RMD1 -180.
D RMD2 -180.
D BAL1 739
D BAL2 834
1EOD
```

The following is an RTAT setup deck for a single balance force and pressure model test.

```
!JOB  OAP-7 PLUS RTAT-4.4     SAMPLE DECK SETUP FOR A FORCE AND PRESSURE MODEL
!PAUSE KEYIN FG,S        MOUNT RAW DATA TAPE ON M9 AND SIFT ON M3
!REWIND M9
!ASSIGN UD=GX,F
!ASSIGN F:500=F500,UD,F
!ASSIGN F:501=F501,UD,F
!ASSIGN F:502=F502,UD,F
!ASSIGN F:503=F503,UD,F
!ASSIGN F:504=F504,UD,F
!ASSIGN F:505=F505,UD,F
!ASSIGN F:511=F511,UD,F
!ASSIGN F:106=LP,F
!ASSIGN F:11=C,F
!ASSIGN F:11=M3,F
!ASSIGN M1=M9,F
!ASSIGN M2=M9,F
!ASSIGN F:101=CVALUE,UD,F
!ASSIGN F:102=CNAME,UD,F
!ASSIGN F:103=TARES,UD,F
!ASSIGN F:104=CALMV,UD,F
!ASSIGN F:108=CALSCR,UD,F
!ASSIGN F:107=CALDATA,FD,F
!ASSIGN F:120=CDATA,UD,F
!ASSIGN F:121=SYSCAL,UD,F
!ASSIGN F:122=CBAL,UD,F
!ASSIGN F:100=OAP,UP,F
!ASSIGN CL=CALDATA,FD,F
!ASSIGN L1=OAP,UP,F
!ASSIGN F:1=TT,F
!ASSIGN F:1=GX,F
!ASSIGN F:600=F600,UD,F
!ASSIGN F:601=F601,UD,F
!ASSIGN F:602=F602,UD,F
!ASSIGN F:603=F603,UD,F
!ASSIGN F:604=F604,UD,F
!ASSIGN F:605=F605,UD,F
!ASSIGN F:611=F611,UD,F
```

```
!ASSIGN F:123=SNAME,UD,F
!ASSIGN F:124=CCOM,UD,F
!ASSIGN F:301=CVALU2,UD,F
!ASSIGN F:302=CNAME2,UD,F
!ASSIGN F:303=TARES2,UD,F
!ASSIGN F:304=CALMV2,UD,F
!ASSIGN F:321=SYSCA2,UD,F
!ASSIGN F:323=SNAME2,UD,F
!ASSIGN F:324=CCOM2,UD,F
!ASSIGN F:125=KNAME,UD,F
!ASSIGN F:325=KNAME2,UD,F
!ASSIGN F:126=A0,F
!ASSIGN F:127=B0,F
!ASSIGN F:2=GX,F
!OAP
9END
!EOD
1 CHNO,1 FSET,1 NAME,NF
1 CHNO,2 FSET,1 NAME,AF
1 CHNO,3 FSET,1 NAME,PM
1 CHNO,4 FSET,1 NAME,RM
1 CHNO,5 FSET,1 NAME,YM
1 CHNO,6 FSET,1 NAME,SF
1 CHNO,7 FSET,2 OFST,0.0 NAME,PC1
1 CHNO,8 FSET,2 OFST,0.0
1 CHNO,9 FSET,2 OFST,0.0
1 CHNO,10 FSET,2 OFST,0.0
1 CHNO,11 FSET,2 OFST,0.0
1 CHNO,12 FSET,2 OFST,0.0
1 CHNO,13 FSET,2 OFST,0.0
1 CHNO,14 FSET,2
1 CHNO,15 FSET,1
1 CHNO,16 FSET,1
1 CHNO,17 FSET,1
1 CHNO,18 FSET,1
1 CHNO,19 FSET,1
1 CHNO,20 FSET,1
1 CHNO,21 FSET,2 OFST,0.0 NAME,S1
1 CHNO,22 FSET,2 OFST,0.0 NAME,S2
```

```
1 CHNO,23 FSET,2 OFST,0.0 NAME,S3
1 CHNO,24 FSET,2 OFST,0.0 NAME,S4
1 CHNO,25 FSET,2
1 CHNO,26 FSET,2
1 CHNO,27 FSET,2
1 CHNO,28 FSET,2
1 CHNO,29 FSET,2
1 CHNO,30 FSET,1
1 CHNO,31 FSET,1
1 CHNO,32 FSET,1
1 CHNO,33 FSET,1 OFST,0.0 NAME,PIND
1 CHNO,34 FSET,1 OFST,0.0
1 CHNO,35 FSET,2 OFST,0.0 NAME,TDEW
1 CHNO,36 FSET,2 OFST,0.0 NAME,TT
1 CHNO,37 FSET,2 OFST,0.0
1 CHNO,38 FSET,2 OFST,0.0
1 CHNO,39 FSET,2 OFST,0.0
1 CHNO,40 FSET,2
1 CHNO,41 FSET,2 OFST,0.0 NAME,G1
1 CHNO,42 FSET,2 OFST,0.0 NAME,G2
1 CHNO,43 FSET,2 OFST,0.0 NAME,G3
1 CHNO,44 FSET,2 OFST,0.0 NAME,G4
1 CHNO,45 FSET,2 OFST,0.0 NAME,G5
1 CHNO,46 FSET,2 OFST,0.0 NAME,G6
1 CHNO,47 FSET,2
1 CHNO,48 FSET,2
1 CHNO,49 FSET,2
1 CHNO,50 FSET,2
1 CHNO,151 LWLM,0 NAME,PI
1 CHNO,152 LWLM,0 NAME,HI
1 CHNO,153
1 CHNO,154
1 CHNO,155 LWLM,0
1 CHNO,156
1 CHNO,157
1 CHNO,158
1 CHNO,159
1 CHNO,160
1 CHNO,161
```

```
1 CHNO,162
1 CHNO,163
1 CHNO,164
1 CHNO,165 NAME,DVM
1 CHNO,166 NAME,CONFIG
1 CHNO,167
1 CHNO,168
1 CHNO,169
1 CHNO,170
3 AVG,65
3 PSSR,1.0
6 TIME,.1
1 CHNO,25 NAME,S5
1 CHNO,26 NAME,S6
5 ILOC,PMOD CON(9,16)
5 ILOC,RMOD CON(17,20)
5 ILOC,HIRF CON(25,28)
5 ILOC,LOAD CON(29,36)
5 ILOC,YAWK CON(29,36)
5 ILOC,CONB  CON(37,40)
5 ILOC,NEWC CON(41,44)
5 ILOC,C10 CON(45,46)
1 CHNO,211
1 CHNO,212
1 CHNO,213
1 CHNO,214
1 CHNO,215
1 CHNO,216
1 CHNO,217
1 CHNO,218
1 CHNO,21 PVID,1
1 CHNO,1 UPLM,4.3698 LWLM,-3.1389
1 CHNO,2 UPLM,5.5028 LWLM,-5.1848
1 CHNO,3 UPLM,7.2768 LWLM,-6.0548
1 CHNO,4 UPLM,5.3227 LWLM,-8.9287
1 CHNO,5 UPLM,5.7438 LWLM,-6.1638
1 CHNO,6 UPLM,4.9244 LWLM,-4.7584
2 SCOD,0
3 FORMAT,B
```

```
6 FRM,1
9 END
!EOD
*SAMPLE DECK SETUP FOR A SINGLE BALANCE FORCE AND PRESSURE MODEL
*
*     NOTE THAT THE MAXIMUM PORT NUMBER IS SET TO 14
*
*
*     ENGINEERING UNIT EQUATIONS
*
NEU 27
*
*OUTPUT  INPUT1    INPUT2    EQU.TYPE++ZERO    SLOPE     INTERCEPT REFERENCE
*EUNAME  NAME      NAME      CODE++++++CODE    VALUE     VALUE     NAME
*
VG1 A41 R1 LINO 1. 0. ZERO
VG21 A45 R21 LINO 1. 0. ZERO
VG7 A43 R7 LINO 1. 0. ZERO
NF A1 VG1 LIYE 186.47269 0. ZERO
AF A2 VG1 LIYE 14.03506 0. ZERO
PM A3 VG1 LIYE 450.06104 0. ZERO
RM A4 VG1 LIYE 210.50482 0. ZERO
YM A5 VG1 LIYE 251.93843 0. ZERO
SF A6 VG1 LIYE 103.27612 0. ZERO
TDW1 A35 ONE LINO 2.307236059 462.1082617 ZERO
TDW2 A40 ONE LINO 2.303610167 462.2167034 ZERO
*TDEW TDW1 ONE LINO 1. 0. ZERO
TDEW TDW2 ONE LINO 1. 0. ZERO
TT A36 ONE LINO 35.211 491.688 ZERO
TT2 A13 ONE LINO 35.211 491.688 ZERO
TDWF TDW1 ONE LINO 1. 0. R459
TTF TT ONE LINO 1. 0. R459
PI D151 ONE LINO .070727 0. ZERO
HI D152 ONE LINO .070727 0. HIRF
PIHI PI HI LINO 1. 0. ZERO
P7 A7 VG7 LIYE 10.7684 0. PI
P8 A8 VG7 LIYE 9.6501 0. PI
P9 A9 VG7 LIYE 10.8799 0. PI
P10 A10 VG7 LIYE 14.9004 0. PI
```

```
THEM A33 ONE ASIN .00619101 -.2392 ZERO
THES A32 ONE ASIN .00472409 -1.3330 ZERO
THET THES ONE LINO 1. 0. ZERO
P100 S10J VG21 LIPO 86.2132 0. PI
ENDO
*
*****
-
*     START OF NBAL LOOP
*
*
*     EXTRA EQUATIONS BEFORE FORCE
*
NEXU 0
ENUU
*
NBAL 1
*
*     FORCE INPUT
*
*
*     BALANCE CALIBRATION DECK
*
INTR
I 1 842A      06-13-75        0 6 AF SF NF RM PM YM   0 2 1 0   0  50
I  17   .99996024       -.49003846E-02  -.76480398E-04   .14017418E-02
I  21  -.20323115E-01   -.11854793E-01  -.19346301E-03   1.0010212
I  25  -.24923430E-01   -.10938548      -.16366810      -.96055827E-02
I  29  -.87414093E-02   -.28002806E-02   1.0002902        .93948554E-03
I  33   .24666286E-01    .42840011E-02  -.62617435E-03  -.72999339E-02
I  37   .35291086E-02   1.0056104        .29533088E-02  -.65441953E-01
I  41   .17759251E-02   -.17994689E-02   .88315070E-02   .35626218E-03
I  45   1.0004821         .26166377E-02   .28005180E-03   .85914829E-02
I  49   .92819095E-03   -.74696738E-01   .39417877E-02   1.0047436
I  57   0.               0.               .18068018E-05  -.42015475E-06
I  61  -.44567438E-07    .35779401E-05  -.22566894E-06  -.48114023E-04
I  65   .18270739E-04   -.14118595E-04   .72770088E-05   .11059252E-04
I  69   .19653981E-04   -.86532066E-05  -.45505170E-06   .22300170E-08
I  73   .34803919E-10   -.63789037E-09   .92484359E-08   .53947582E-08
```

```
I  77  -.48222210E-06  -.83324416E-07  -.92192118E-08   .74420060E-06
I  81  -.29563450E-07  -.10013576E-04   .48736542E-06  -.31068693E-05
I  85  -.13218857E-06  -.66209430E-05  -.20717398E-04   .42213615E-06
I  89  -.33679501E-05   .16504907E-07   .25759240E-09  -.47211842E-08
I  93   .68449959E-07   .39927938E-07  -.50185907E-06   .66641571E-06
I  97  -.82652600E-07   .17219982E-05  -.83070573E-05  -.13902392E-06
I 101  -.33399377E-06   .26193492E-07  -.46967787E-05  -.71291618E-08
I 105  -.64573149E-05  -.32176802E-07  -.63012494E-07  -.19501174E-07
I 109   .36569352E-07   .18934184E-05   .33968100E-05  -.11347514E-06
I 113   .21363680E-05  -.54308332E-08  -.25012646E-07   .19993590E-08
I 117  -.28585385E-05  -.32748777E-07  -.29638620E-05  -.89768556E-07
I 121   .28233828E-08   .72417712E-08   .77289785E-07   .36138382E-07
I 125   .10421534E-08   .39183192E-05  -.90263183E-07  -.89929680E-06
I 129  -.60649896E-06   .63807019E-05   .19212164E-05  -.15773099E-07
I 133  -.63374413E-09   .57963057E-07  -.41967473E-07  -.76620887E-06
I 137   .17766308E-06  -.38746454E-06   .26517441E-07   .48029424E-06
I 141   .19300891E-05  -.75168438E-06   .23154557E-05  -.14101797E-07
I 145   .11540811E-08   .38256621E-06  -.45949945E-07  -.52138093E-07
I 149   .19532108E-09   .43347587E-06  -.32599623E-08   .79274890E-06
I 153  -.50724168E-07   .33522639E-05  -.30265244E-05   .20455871E-07
I 157  -.27505514E-07  -.53536465E-08  -.30807547E-05   .27596211E-07
I 161   .42908802E-06  -.27521808E-08  -.11195501E-08   .13331257E-06
I 165  -.18423261E-06  -.14192120E-07  -.12363856E-08  -.17648105E-06
I 169  -.86157961E-08  -.10178429E-05  -.10172503E-05  -.21797891E-06
I 173  -.23497556E-06   .11515164E-08   .17971739E-10  -.32938816E-09
I 177   .47756252E-08   .27856973E-08  -.35648771E135   0.
I 189   0.              0.              0.              .70290500E-01
I 193   .51813470       .93457940       1.0555947       2.2556391
I 197  1.2647555        .70290500E-02   .51813470E-01   .93457940E-01
I 201   .10555947       .22556391       .12647555       120.00000
I 205  120.00000        120.00000       120.00000       120.00000
I 209  120.00000        120.00000       120.00000       120.00000
I 213  120.00000        120.00000       120.00000       0.
*
D PHIK 180.
D RMD1 -180.
*
*     DEFINE BALANCE ATTITUDE
*
```

```
*ROTATIONS FROM GRAVITY TO BALANCE
NGB 7
YAWK YAW
THET PITCH
PMOD PITCH
PHIK ROLL
RMOD ROLL
YAWS YAW
ALPS PITCH
PHIS ROLL
*
*     DEFINE MODEL ATTITUDE
*
*ROTATIONS FROM BALANCE TO MODEL
NBM 1
RMD1 ROLL
*
*
*     DEFINE DEFLECTION CONSTANTS
*
D NFDF .0024151
D PMDF .00035245
D SFDF .0049572
D YMDF .00057428
D RMDF .00077639
*
*     DEFINE MOMENT TRANSFER DISTANCES
*
D XBAR -.5
D YBAR 0.
D ZBAR 0.417
*
ENDF
*
*     DEFINE MODEL REFERENCE DIMENSIONS
*
D S 1.0464
D CBAR 5.24376
D B 29.6052
```

```
*
*      DEFINE BLOCKAGE AND JET BOUNDARY CORRECTIONS
*
BLK 1
*
D KWI .000665
D KBI .000157
D J1 .0019517
D J2 .11183
D J3 .00187
*
*BASE PRESSURE CORRECTIONS
*
NBAS 2
*OUTPUT INPUT AREAS     AREAS*ARMS  FLAG
*NAME   NAME  AF SF NF RM PM YM
*
CPB1 P8 .006281 0 0 0 0 0 1.
CPB2 P9 .006281 0 0 0 0 0 1.
*
*CHAMBER PRESSURE CORRECTIONS
NCBR 1
*
*OUTPUT INPUT AREAS     AREAS*ARMS  FLAG
*NAME   NAME  AF SF NF RM PM YM
*
CPC1 P7 .01989 0 0 0 0 0 1.
*
*      DEFINE PRESSURE COEFFICIENT ARRAYS
*
NCP 1
C101 P101 14
*
*      DEFINE PRESSURE RATIO ARRAYS
*
NRTO 13
*DATA FOR FIRST PLOT QUADRANT
Q1 P102 HI 1
Q1A P106 HI 1
```

```
Q1B P110 HI 1
*DATA FOR SECOND PLOT QUADRANT
Q2 P103 HI 1
Q2A P107 HI 1
Q2B P111 HI 1
*DATA FOR THIRD PLOT QUADRANT
Q3 P104 HI 1
Q3A P108 HI 1
Q3B P112 HI 1
*DATA FOR FOURTH PLOT QUADRANT
Q4 P105 HI 1
Q4A P109 HI 1
Q4B P113 HI 1
*GENERATE PRESSURE RATIOS FOR PRINTOUT
PR01 P101 HI 14
*
*     DEFINE FLOW METERS
*
NFLO 0
*
*
*     EXTRA EQUATIONS AFTER FORCE
*
NEXF 0
ENDX
*
*     DEFINE DISPLAY THUMBWHEELS
*
NDSP 35
VINF 700 RHO 701 RH 702 TDWF 735 TTF 736
NF 301 AF 302 PM 303 RM 304 YM 305 SF 306 P7 307 P8 308 P9 309 P10 310
CL 401 CD 402 CMS 403 CRMS 404 CYMS 405 CYS 406
                  ALPW 433 BETA 434 ALPG 335 PHIG 336
TDEW 435 TT 436 REYN 801 TDWF 835 TTF 836 PI 851 HI 852 MACH 853 QINF 854 PT 855
ENDD
*
*
*     POINT-BY-POINT LINE PRINTER OUTPUT
*
```

```
NPG 13
*
PG00 ALPW BETA MACH 10.3 QINF 10.3 YAWZ
*
PG00 PI 10.3 HI 10.3 P1 10.3 TT 10.1 TDEW 10.1 TT2 10.1 TDW2 10.1
*
PG00 NF AF PM RM YM SF CPB1 CPB2
*
PG00 NFC AFC PMC RMC YMC SFC CPC1
*
PG00 NFTA AFTA PMTA RMTA YMTA SFTA     AFB XAFB
*
PG00 NFBA AFBA PMBA RMBA YMBA SFBA     AFCH XAFC
*
PG00 NFTO AFTO PMTO RMTO YMTO SFTO REYN
*
PG00 NFMA AFMA PMMA RMMA YMMA SFMA
*
PG00 CN CA CM CRM CYM CY      DELA DELM
*
PG00 CL CD CMS CRMS CYMS CYS L/D 12.5 P7 10.3 P8 10.3  P9 10.3
*
PG00 RMD1 ALPZ PHIZ ALPS PHIS YAWS ALPG PHIG YAWG
*
PG00 S100
*
PG14 S101 P101 C101 T000 R000 PRC1
*
ENDP
*
*
*
*     SUMMARY LINE PRINTER OUTPUT
*
*
*
NGP 1
*
GP12 ID 4.0 TP 7.0 MACH  6.3 QINF 10.3 ALPW BETA CL CD CMS CRMS CYMS CYS
```

ORIGINAL PAGE IS OF POOR QUALITY

```
*
ENDG
*
*
*
*     REORDER HOOKUP FOR PLOTTING
*
*
*
NHOOK 0
*
ENDH
*
*
*
*     POINT-BY-POINT PLOT OUTPUT
*
*
*
NPLT 4
*
R101 0. .2 RAD Q1 .8 .05 PR79 3 1
*
R201 0. .2 RAD Q2 .8 .05 PR56 3 4
*
R301 0. .2 RAD Q3 .8 .05 PR33 3 6
*
R401 0. .2 RAD Q4 .8 .05 PR10 3 3
*
ENDT
*
*
*
*     ADDITIONAL POINT-BY-POINT PRESSURE PLOTS
*
*
*
*
MPLT 0
```

```
ENDM
*
*      SUMMARY PLOTS
*
SPLT 4
ALPW -5. 5. ALPW CL -.4 .4 CL 1 1
ALPW -5. 5. ALPW CMS -.1 .1 CMS 1 4
ALPW -5. 5. ALPW CD 0. .1 CD 1 6
ALPW -5. 5. ALPW CYMS -.08 .04 CYMS 1 3
ENDS
*
*****
*
*      END OF NBAL LOOP
*
*
*      ASSORTED CONSTANTS
*
D ZERO 0.0
D ONE 1.0
D R0 1.
D R1 5.002
D R7 5.997
D R21 6.0016
D R32 29.8241
D R33 30.0097
D R459 -459.688
D REFL 1.
D ALPU 0.0
D XFLO 0.
D KDFL DELTA
D JETX 0 UNEK 0 GRID 1
*
*      INFORMATION AFTER SOUT IS RETAINED IN THE DATA BASE
*
SOUT
*
D KJ .004024
D PHIK 180.
```

```
D RMD1 -180.
*
*     R AND THETA LOCATIONS OF THE ORIFICES FOR USE WITH PLOTTING AND PRINTING
*
D R101 .687 R102 .458 R103 .229
D R201 .714 R202 .476 R203 .238
D R301 .738 R302 .492 R303 .246
D R401 .738 R402 .492 R403 .246
D R000 -999. R001 .687 R002 .714 R003 .738 R004 .738 R005 .458 R006 .476
D R007 .492 R008 .492 R009 .229 R010 .238 R011 .246 R012 .246 R013 -999.
*
D T000 -999 T001 79 T002 56 T003 33 T004 10 T005 79 T006 56 T007 33 T008 10
D T009 79 T010 56 T011 33 T012 10 T013 -999
*
*
!EOD
```

APPENDIX G

RTAT COMPUTATIONAL SPECIFICATIONS

RTAT Raw Data Input

Raw data values are obtained from the data acquisition system by the OAP, which averages them over a test point and places the results in an averaged record buffer. RTAT obtains these values and places them in the data base. The following conventions are used in assigning names to the raw data values:

(a) Digital channel data are designated by the letter "D" followed by the channel number; e.g., D151 and D166.

(b) Analog channel data (non-scanivalve data only) are designated by the letter "A" followed by the channel number; e.g., A1 and A47.

(c) Scanivalve data are designated by the letter "S" followed by a three-digit number giving the valve number and port number; e.g., S237 for valve 2, port 37. The first two characters, e.g., S2, are obtained from the OAP channel name table.

(d) Tachometer channel data are designated by the letter "T" followed by the channel number; e.g., T211.

(e) The letter "V" followed by a three digit channel number has been reserved for the future for a Vidar data channel.

(f) The first four characters of the Digital Constant Panel names defined in the OAP setup cards.

For analog data (including scanivalve data), RTAT converts the raw data to uncorrected millivolts and then applies system calibrates to obtain corrected millivolts which it places in the data base.

APPENDIX G

Engineering Units

RTAT expects the Keyword NEU to be available in the data base. If NEU is not found, or if it is less than 1, no engineering unit conversion equations will be executed.

The engineering unit conversion equations will handle absolute and differential transducers having linear calibration equations or linear equations with plus and minus slopes. They will handle Kearfott arcsine equations and Baratron multiple range equations. They will also handle scanivalve multiplexed differential pressure transducers.

The engineering unit input specifications are given in APPENDIX C with additional details on the equations implemented.

The results obtained through executing the engineering unit equations are added to the end of the data base. Then the engineering unit specifications are collapsed out of the data base.

Tunnel Parameters

RTAT expects to find the following data items in the data base: PI, HI, TT, TDEW, and REFL.

The following equations are used to compute the tunnel flow parameters. Some of the numeric constants are derived from tunnel calibrations and apply only to the Langley 7- by 10-foot high speed tunnel. (See references 1 and 2.)

APPENDIX G

The free stream test section static pressure is computed as:

For $(\frac{PI}{HI}) \leq 0.62474$,

$$P1 = [1.051280 * (\frac{PI}{HI}) - 0.030756] * HI$$

For $(\frac{PI}{HI}) > 0.62474$,

$$P1 = [0.995865 * (\frac{PI}{HI}) + 0.004020] * HI$$

The relative humidity is computed as

VAP1 = PSAT(TDEW)

VAP2 = PSAT(TT)

$$RH = [\frac{VAP1}{VAP2}] * 100$$

where PSAT is a function which gives the saturation vapor pressure of water in air at a given temperature.

Free stream test section Mach number is computed as:

$$\text{MACH} = \sqrt{5*[(\text{HI}/\text{P1})^{2/7} - 1]}$$

Free stream test section dynamic pressure is computed as:

$$\text{QINF} = 0.7*\text{P1}*\text{MACH}^2$$

Free stream test section density is computed as:

$$\text{RHO} = \frac{\left[\dfrac{1}{1 + 0.2 * \text{MACH}^2}\right]^{2.5} *(\text{HI} - .379 * \text{VAP1})}{1714.8742*\text{TT}}$$

Free stream test section static temperature is computed as:

$$\text{TINF} = \text{TT}/(1 + 0.2 * \text{MACH}^2)$$

Reynolds number in millions based on the length REFL is computed as:

$$\text{VINF} = \sqrt{2 * \text{QINF}/\text{RHO}}$$

$$\text{VISC} = \frac{2.27 * (\text{TINF} + 459.688)^{3/2} * 10^{-8}}{\text{TINF} + 658.288}$$

$$\text{REYN} = \frac{\text{RHO} * \text{VINF} * \text{REFL}}{\text{VISC}} * 10^{-6}$$

Note that the default value for REFL is unity.

APPENDIX G

RTAT appends the following to the data base: P1, QINF, MACH, TINF, VAP1, VAP2, RH, RHO, VISC, VINF, REYN.

RTAT Force Data

RTAT expects the Keyword NBAL to be available in the data base. If NBAL is not found, or if it is less than 1, the entire NBAL loop will be skipped. Since the model attitude calculations are part of the NBAL loop, NBAL is often set to 1 even in the absence of a balance.

Extra Equations Before Force

RTAT has the capability to execute extra equations before the force computations. The input specifications for this capability is given in APPENDIX D along with the algorithms.

Corrections for Balance Interactions (See reference 3)

RTAT expects to find the following uncorrected or indicated balance components in the data base: NF, AF, PM, RM, YM, SF. (See Figure G-1.) These components are referred to as "delta" components because they are relative to a wind-off zero recording of initial loads. These components are treated as a 6 x 1 column vector denoted by [FU], where:

$$[FU] = \begin{bmatrix} AF \\ SF \\ NF \\ RM \\ PM \\ YM \end{bmatrix}$$

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Let the components corrected for interactions be denoted [F], where:

$$[F] = \begin{bmatrix} AFC \\ SFC \\ NFC \\ RMC \\ PMC \\ YMC \end{bmatrix}$$

First Order Interactions

For first order interactions, the balance calibration establishes the following matrix relationship between correct and indicated components:

$$[FU] = [C1][F]$$

where [C1] is a 6 x 6 matrix which is the normalized first order interaction coefficient matrix with main diagonal elements of unity.

Provided [C1] is non-singular, the correct delta components are found from:

$$[F] = [C1I][FU]$$

where [C1I] is the inverse of [C1].

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Second Order Interactions

For second order interactions, the balance calibration establishes the following matrix relationship between correct and indicated components:

$$[FU] = [C1][F] + [C2][F2]$$

where $[C2]$ is a 6 x 21 matrix which is the normalized second order interaction coefficient matrix and $[F2]$ is a 21 x 1 matrix of product combinations of $[F]$ as follows:

$$[F2] = \begin{bmatrix} AFC*AFC \\ AFC*SFC \\ AFC*NFC \\ AFC*RMC \\ AFC*PMC \\ AFC*YMC \\ SFC*SFC \\ SFC*NFC \\ SFC*RMC \\ SFC*PMC \\ SFC*YMC \\ NFC*NFC \\ NFC*RMC \\ NFC*PMC \\ NFC*YMC \\ RMC*RMC \\ RMC*PMC \\ RMC*YMC \\ PMC*PMC \\ PMC*YMC \\ YMC*YMC \end{bmatrix}$$

Provided [C1] is non-singular, the correct delta components are found from:

$$[F] = [C1I][FU] - [C1IC2][F2]$$

where [C1IC2] is the product of the inverse of [C1] and [C2], that is [C1IC2] = [C1I][C2]. This equation must be solved iteratively because [F] is expressed in terms of [F2] which is itself a function of [F].

RTAT expects to find the matrices [C1I] and [C1IC2] in the data base following the Keyword INTR as described in Appendix C.

Translation for Initial Loads

Since second order interactions are nonlinear, the tunnel force and moment components must be related to the same origin as the balance calibration. Typically, the balance calibration establishes an origin with zero output corresponding to zero load. Typically, the tunnel establishes an origin corresponding to an initial load where the initial load is defined as the correct balance components due to model weight computed for a wind-off zero recording. Since the tunnel subtracts the initial loads from subsequent data, the tunnel establishes an origin of zero output corresponding to the initial loads. Therefore, a translation of axes for initial loads may be necessary before the tunnel can use the matrix relationship established by the balance calibration.

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Let $[FU_o]$ denote the indicated initial loads,

$[F_o]$ denote the correct initial loads,

$[FUT]$ denote the indicated total loads, and

$[FT]$ denote the correct total loads,

where

$$[FT] = \begin{bmatrix} AFTO \\ SFTO \\ NFTO \\ RMTO \\ PMTO \\ YMTO \end{bmatrix}$$

By definition

$$[FUT] = [FU] + [F_o]$$

and

$$[FT] = [F] + [F_o]$$

Note that

$$[FU_o] = \begin{bmatrix} WAF \ \sin\alpha_o \\ WSF \ \sin\phi_o \cos\alpha_o \\ -WNF \ \cos\phi_o \cos\alpha_o \\ WZRM \sin\phi_o \cos\alpha_o + WYRM \cos\phi_o \cos\alpha_o \\ WZPM \sin\alpha_o - WXPM \cos\phi_o \cos\alpha_o \\ WXYM \sin\phi_o \cos\alpha_o + WYYM \sin\alpha_o \end{bmatrix}$$

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The second order interaction relationship between correct and indicated components for the tunnel is then:

$$[FT] = [C1I][FUT] - [C1IC2][F2T]$$

where $[F2T]$ is just $[F2]$ based on $[FT]$. This equation must be solved iteratively.

Note that for initial loads, this becomes

$$[F_o] = [C1I][FU_o] - [C1IC2][F2_o]$$

where $[F2_o]$ is just $[F2]$ based on $[F_o]$.

Now, for the i^{th} iteration, let

$$[\varepsilon_i] = [C1IC2][F2T]$$

and specifically, for initial loads, let

$$[\varepsilon_o] = [C1IC2][F2_o]$$

The iteration technique is then given by:

Iteration	[FT] Approximation	Error
0	$[C1I][FU] + [C1I][FU_o]$	$[\varepsilon_o]$
1	$[C1I][FU] + [C1I][FU_o] - [\varepsilon_o]$	$[\varepsilon_1]-[\varepsilon_o]$
2	$[C1I][FU] + [C1I][FU_o] - [\varepsilon_1]$	$[\varepsilon_2]-[\varepsilon_1]$
3	$[C1I][FU] + [C1I][FU_o] - [\varepsilon_2]$	$[\varepsilon_3]-[\varepsilon_2]$
•		
•		
•		

This iteration is continued until $\{[\varepsilon_i] - [\varepsilon_{i-1}]\}$ is less than the specified accuracy for all components which is obtained from the balance calibration.

The correct delta components are then calculated from

$$[F] = [FT] - [F_o]$$

For a wind-off zero, RTAT saves $[F_o]$ in a COMMON area.

RTAT places the following in the data base: AFC, SFC, NFC, RMC, PMC, YMC, AFTO, SFTO, NFTO, RMTO, PMTO, YMTO.

Computation of Sting Deflections

Sting deflection (or bending) occurs due to loads applied through the model. Devices used to measure angles defining balance and model attitude may be so located that they do not record these deflections. Consequently, sting deflection angles must be computed as a function of correct balance loads. The deflection angles are assumed to be small enough so that the sting responds elastically, allowing the angle to be described as a spring constant times a load.

RTAT expects the Keyword KDFL to be available in the data base. If KDFL is not found in the data base, it is set to TOTAL. If KDFL is equal to DELTA, RTAT computes deflections based on currect delta loads as:

YAWS = SFC * SFDF + YMC * YMDF

ALPS = NFC * NFDF + PMC * PMDF

PHIS = RMC * RMDF

If KDFL is equal to DELTA, RTAT next computes the initial deflections as:

YAWI = 0.0

ALPI = 0.0

PHII = 0.0

If KDFL is equal to TOTAL, RTAT computes deflections based on correct total loads as:

YAWS = SFTO * SFDF + YMTO * YMDF

ALPS = NFTC * NFDF + PMTO * PMDF

PHIS = RMTO * RMDF

If KDFL is equal to TOTAL, RTAT next computes the negative of the initial deflection as:

YAWI = -YAWS

ALPI = -ALPS

PHII = -PHIS

RTAT appends the following to the data base: YAWS, ALPS, PHIS, YAWI, ALPI, AND PHII.

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Computation of Balance Attitude

The attitude of the balance with respect to gravity is determined on the basis of a specified input rotation scheme which consists of an ordered set of orthogonal Eulerian transformations. Each transformation rotates the components of a vector through a specified angle about a specified axis. The final result is the transformation of the components of a vector from the gravity axis system to the balance axis system. The axis systems used are right-hand Cartesian systems.

Consider a rotation angle denoted by γ. The orthogonal transformation matrices describing a rotation through angle γ about each of the three possible axes are:

$$\text{Roll:} \quad R_x(\gamma) = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos\gamma & -\sin\gamma \\ 0 & \sin\gamma & \cos\gamma \end{bmatrix}$$

$$\text{Pitch:} \quad [R_y(\gamma)] = \begin{bmatrix} \cos\gamma & 0 & -\sin\gamma \\ 0 & 1 & 0 \\ \sin\gamma & 0 & \cos\gamma \end{bmatrix}$$

$$\text{Yaw:} \quad [R_z(\gamma)] = \begin{bmatrix} \cos\gamma & -\sin\gamma & 0 \\ \sin\gamma & \cos\gamma & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

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The resultant transformation matrix $[R]$ which describes the attitude of the balance with respect to gravity then follows from successive applications of the appropriate individual transformations. Assuming n rotations, this can be written

$$[R_{gb}] = [R_a(\gamma_n)][R_a(\gamma_{n-1})] \; . \; . \; . \; [R_a(\gamma_2)][R_a(\gamma_1)]$$

where a is either x, y, or z as specified for each γ.

The balance attitude $[R_{gb}]$ can also be summarized as a single yaw rotation YAWG, followed by a single pitch rotation ALPG, followed by a single roll rotation PHIG. That is:

$$[R_{gb}] = [R_x(\text{PHIG})][R_y(\text{ALPG})][R_z(\text{YAWG})]$$

$$= [R_x(\phi_g)][R_y(\alpha_g)][R_z(\psi_g)]$$

Substituting and carrying out the indicated multiplications yields:

$$\left[R_{gb}\right] = \begin{bmatrix} R11 & R12 & R13 \\ R21 & R22 & R23 \\ R31 & R32 & R33 \end{bmatrix} =$$

$$\begin{bmatrix} \cos\alpha_g \cos\psi_g & -\cos\alpha_g \sin\psi_g & -\sin\alpha_g \\ \cos\phi_g \sin\psi_g - \sin\phi_g \sin\alpha_g \cos\psi_g & \cos\phi_g \cos\psi_g + \sin\phi_g \sin\alpha_g \sin\psi_g & -\sin\phi_g \cos\alpha_g \\ \sin\phi_g \sin\psi_g + \cos\phi_g \sin\alpha_g \cos\psi_g & \sin\phi_g \cos\psi_g - \cos\phi_g \sin\alpha_g \sin\psi_g & \cos\phi_g \cos\alpha_g \end{bmatrix}$$

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Solving for YAWG, ALPG, and PHIG gives:

$$\text{YAWG} = \arctan(-R12/R11) + \psi_q = -\arctan(R12/R11) + \psi_q$$

$$\text{ALPG} = \arcsin(-R13) = -\arcsin(R13)$$

$$\text{PHIG} = \arctan(-R23/R33) + \phi_q = -\arctan(R23/R33) + \phi_q$$

under the following restrictions:

$$-\frac{\pi}{2} \leq \text{ALPG} \leq \frac{\pi}{2}$$

If R11 > 0 and R12 > 0, $\psi_q = 0$

If R11 > 0 and R12 < 0, $\psi_q = 0$

If R11 > 0 and R12 = 0, YAWG = 0

If R1l < 0 and R12 < 0, $\psi_q = -180$
If R11 < 0 and R12 < 0, $\psi_q = 180$
If R11 < 0 and R12 = 0, $\psi_q = \pm 180$

If R11 = 0 and R12 > 0, YAWG = -90

If R11 = 0 and R12 < 0, YAWG = 90

If R11 = 0 and R12 = 0, YAWG = 0
If R11 > 0 and R12 > 0, $\phi_q = 0$
If R33 > 0 and R23 < 0, $\phi_q = 0$

If R33 > 0 and R23 = 0, PHIG = 0

If R33 < 0 and R23 0, $\phi_q = -180$

If R33 < 0 and R23 = 0, $\phi_q = 180$

If R33 < 0 and R23 = 0, PHIG = ±180

If R33 = 0 and R23 > 0, PHIG = -90

If R33 = 0 and R23 < 0, PHIG = 90

If R33 = 0 and R23 = 0, PHIG = 0

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For the gravity to balance matrix $[R_{gb}]$, RTAT expects the Keyword NGB to be available in the data base followed by the rotation scheme. If NGB is not found, RTAT assume a single pitch rotation of zero degrees. The elements of the balance attitude transformation are computed from NGB successive applications of the individual transforms.

RTAT appends the following to the data base: R11, R21, R31, R12, R22, R32, R13, R23, R33, YAWG, ALPG, and PHIG. For the special case of the balance attitude with respect to gravity during a wind-off zero recording, the angles YAWG, ALPG, and PHIG are given the special names YAWZ, ALPZ, and PHIZ and appended to the data base.

Weight Tare Computations

RTAT iteratively computes the nine weight tare factors (three weights and six weights times arms) used in the reduction of force balance data. These factors are computed based on wind-off weight tare recordings made at various balance attitudes.

Note that, for the wind-off zero recording, weight tares are referred to as initial loads and are subtracted from each wind-on recording which removes the effects of initial loads. Since data are recorded at attitudes other than the wind-off zero attitude, the data must be corrected for delta weight tares.

The model weight is a vector $\vec{W}$. Consider the gravity axis system, it is apparent that there are no horizontal components of weight and that the vertical component is directed downward. The weight vector in the gravity axis system $\vec{W}_g$ is then

$$\vec{W}_g = (W_{gx}, W_{gy}, W_{gz}) = (0,0,-W)$$

where W is the magnitude of $\vec{W}_g$ at attitude $[R]$. Because the x and y components of $\vec{W}_g$ are zero, only the third column of $[R_{gb}]$ needs to be considered.

Force Weight Tare Computations

Consider the third column of $[R_{gb}]$, denoted $[R3]$, which is

$$[R3] = \begin{bmatrix} -\sin \text{ALPG} \\ -\sin \text{PHIG} \cos \text{ALPG} \\ \cos \text{PHIG} \cos \text{ALPG} \end{bmatrix} = \begin{bmatrix} -\sin \alpha_g \\ -\sin \phi_g \cos \alpha_g \\ \cos \phi_g \cos \alpha_g \end{bmatrix}$$

For the wind-off zero recording $[R3]$ becomes $[R3_o]$:

$$[R3_o] = \begin{bmatrix} -\sin \text{ALPZ} \\ -\sin \text{PHIZ} \cos \text{ALPZ} \\ \cos \text{PHIZ} \cos \text{ALPZ} \end{bmatrix} = \begin{bmatrix} -\sin \alpha_o \\ -\sin \phi_o \cos \alpha_o \\ \cos \phi_o \cos \alpha_o \end{bmatrix}$$

The delta weight tares are defined as the change in balance components due solely to model weight W, relative to initial loads, and are computed as:

$$\begin{bmatrix} \text{AFTA} \\ \text{SFTA} \\ \text{NFTA} \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ -W \end{bmatrix} [R_{gb}] - \begin{bmatrix} 0 \\ 0 \\ -W \end{bmatrix} [R_o]$$

where $[R_o]$ is $[R_{gb}]$ for the wind-off zero recording. Now let

$$[V] = \begin{bmatrix} V1 \\ V2 \\ V3 \end{bmatrix} = [R3] - [R3_o] = \begin{bmatrix} (\sin \alpha_g - \sin \alpha_o) \\ (\sin \phi_g \cos \alpha_g - \sin \phi_o \cos \alpha_o) \\ -(\cos \phi_g \cos \alpha_g - \cos \phi_o \cos \alpha_o) \end{bmatrix}$$

Then the delta force weight tares can be expressed as:

$$\begin{bmatrix} AFTA \\ SFTA \\ NFTA \end{bmatrix} = W[V] = \begin{bmatrix} W(\sin \alpha_g - \sin \alpha_o) \\ W(\sin \phi_g \cos \alpha_g - \sin \phi_o \cos \alpha_o) \\ -W(\cos \phi_g \cos \alpha_g - \cos \phi_o \cos \alpha_o) \end{bmatrix}$$

Now, recognizing that the force beams of a balance may each sense a different portion of the balance's own weight as well as the model weight, this equation may be rewritten as:

$$\begin{bmatrix} AFTA \\ SFTA \\ NFTA \end{bmatrix} = \begin{bmatrix} WAF\ (\sin \alpha_g - \sin \alpha_o) \\ WSF(\sin \phi_g \cos \alpha_g - \sin \phi_o \cos \alpha_o) \\ -WNF\ (\cos \phi_g \cos \alpha_g - \cos \phi_o \cos \alpha_o) \end{bmatrix} = \begin{bmatrix} WAF*V1 \\ WSF*V2 \\ WNF*V3 \end{bmatrix}$$

The solution of this equation may be written

$$WAF = \frac{AFTA}{V1}$$

$$WSF = \frac{SFTA}{V2}$$

$$WNF = \frac{NFTA}{V3}$$

provided the denominators are not zero.

In actual practice, several weight tare recordings are made at different balance attitudes which results in an overly defined system of equations. The solution for the force weight tares will be written in the following particular form for consistency with the moment weight tares. Assuming n weight tare recordings, the solution is written

$$WAF = \frac{\sum_{i=1}^{n} (AFTA_i * V1_i)}{DTAF}$$

$$WSF = \frac{\sum_{i=1}^{n} (SFTA_i * V2_i)}{DTSF}$$

$$WNF = \frac{\sum_{i=1}^{n} (NFTA_i * V3_i)}{DTNF}$$

where the denominators are:

$$DTAF = \sum_{i=1}^{n} (V1_i * V1_i)$$

$$DTSF = \sum_{i=1}^{n} (V2_i * V2_i)$$

$$DTNF = \sum_{i=1}^{n} (V3_i * V3_i)$$

Let DELW represent the delta weight from the balance calibration and let DETF represent a tolerance level for the force weight tares.

Computationally WAF, WSF and WNF are initialized to zero and the force weight tares calculated as follows:

$$\text{If } DTAF > DETF, \quad WAF = \frac{\sum_{i=1}^{n} (AFTA_i * V1_i)}{DTAF}$$

$$\text{If } DTSF > DETF, \quad WSF = \frac{\sum_{i=1}^{n} (SFTA_i * V2_i)}{DTSF}$$

$$\text{If } DTNF > DETF, \quad WNF = \frac{\sum_{i=1}^{n} (NFTA_i * V3_i)}{DTNF}$$

If DTAF < DETF and $\begin{cases} WSF \neq 0,\ WAF = WSF - DELW \\ WNF \neq 0,\ WAF = WNF - DELW \end{cases}$

If DTSF < DETF and $\begin{cases} WAF \neq 0,\ WSF = WAF + DELW \\ WNF \neq 0,\ WSF = WNF \end{cases}$

If DTNF < DETF and $\begin{cases} WAF \neq 0,\ WNF = WAF + DELW \\ WSF \neq 0,\ WNF = WSF \end{cases}$

Moment Weight Tare Computations

If transfer distances $\overline{X}, \overline{Y}, \overline{Z}$ are measured in the balance axis system from the balance moment center to the model center of gravity, positive in the directions of positive thrust, side force, and normal force respectively, then the delta moment weight tares are obtained by transferring moments as follows:

$$\begin{bmatrix} RMTA \\ PMTA \\ YMTA \end{bmatrix} = \begin{bmatrix} SFTA*\overline{Z} - NFTA*\overline{Y} \\ AFTA*\overline{Z} + NFTA*\overline{X} \\ SFTA*\overline{X} + AFTA*\overline{Y} \end{bmatrix}$$

Substituting for AFTA, SFTA, and NFTA gives:

$$\begin{bmatrix} RMTA \\ PMTA \\ YMTA \end{bmatrix} = \begin{bmatrix} WSF*V2*\overline{Z} - WNF*V3*\overline{Y} \\ WAF*V1*\overline{Z} + WNF*V3*\overline{X} \\ WSF*V2*\overline{X} + WAF*V1*\overline{Y} \end{bmatrix}$$

which can be rewritten as

$$\begin{bmatrix} RMTA \\ PMTA \\ YMTA \end{bmatrix} = \begin{bmatrix} WZRM*V2 - WYRM*V3 \\ WZPM*V1 + WXPM*V3 \\ WXYM*V2 + WYYM*V1 \end{bmatrix}$$

Writing the individual equations gives:

$$[RMTA] = [V2 \ - \ V3] \begin{bmatrix} WZRM \\ WYRM \end{bmatrix}$$

$$[PMTA] = [V1 \quad V3] \begin{bmatrix} WZPM \\ WXPM \end{bmatrix}$$

$$[YMTA] = [V2 \quad V1] \begin{bmatrix} WXYM \\ WYYM \end{bmatrix}$$

Each of these equations is solved for the weight tare factors by first premultiplying both sides of the equation by the transpose of the row vector on the right containing the V terms. The solution then involves inverting the matrix obtained from the transpose of the row vector times the row vector itself.

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Recalling that in actual practice, several weight tare recordings are made, the solutions obtained are then:

$$WZRM = \frac{\sum_{i=1}^{n}(V3_i*V3_i)*\sum_{i=1}^{n}(RMTA_i*V2_i) - \sum_{i=1}^{n}(V2_i*V3_i)*\sum_{i=1}^{n}(RMTA_i*V3_i)}{DTRM}$$

$$WYRM = \frac{\sum_{i=1}^{n}(V2_i*V3_i)*\sum_{i=1}^{n}(RMTA_i*V2_i) - \sum_{i=1}^{n}(V2_i*V2_i)*\sum_{i=1}^{n}(RMTA_i*V3_i)}{DTRM}$$

$$WZPM = \frac{\sum_{i=1}^{n}(V3_i*V3_i)*\sum_{i=1}^{n}(PMTA_i*V1_i) - \sum_{i=1}^{n}(V1_i*V3_i)*\sum_{i=1}^{n}(PMTA_i*V3_i)}{DTPM}$$

$$WXPM = \frac{\sum_{i=1}^{n}(V1_i*V1_i)*\sum_{i=1}^{n}(PMTA_i*V3_i) - \sum_{i=1}^{n}(V1_i*V3_i)*\sum_{i=1}^{n}(PMTA_i*V1_i)}{DTPM}$$

$$WXYM = \frac{\sum_{i=1}^{n}(V1_i*V1_i)*\sum_{i=1}^{n}(YMTA_i*V2_i) - \sum_{i=1}^{n}(V2_i*V1_i)*\sum_{i=1}^{n}(YMTA_i*V1_i)}{DTYM}$$

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$$WYYM = \frac{\sum_{i=1}^{n} (V2_i * V2_i) * \sum_{i=1}^{n} (YMTA_i * V1_i) - \sum_{i=1}^{n} (V2_i * V1_i) * \sum_{i=1}^{n} (YMTA_i * V2_i)}{DTYM}$$

where the denominators are:

$$DTRM = \sum_{i=1}^{n} (V2_i * V2_i) * \sum_{i=1}^{n} (V3_i * V3_i) - \sum_{i=1}^{n} (V2_i * V3_i) * \sum_{i=1}^{n} (V2_i * V3_i)$$

$$DTPM = \sum_{i=1}^{n} (V1_i * V1_i) * \sum_{i=1}^{n} (V3_i * V3_i) - \sum_{i=1}^{n} (V1_i * V3_i) * \sum_{i=1}^{n} (V1_i * V3_i)$$

$$DTYM = \sum_{i=1}^{n} (V1_i * V1_i) * \sum_{i=1}^{n} (V2_i * V2_i) - \sum_{i=1}^{n} (V1_i * V2_i) * \sum_{i=1}^{n} (V1_i * V2_i)$$

Let DETM represent a tolerance level for the moment weight tares.

Computationally, WZRM, WYRM, WZPM, WXPM, WXYM, and WYYM are calculated as follows:

If $|DTRM| > DETM$,

$$WZRM = \frac{\sum_{i=1}^{n} (V3_i * V3_i) * \sum_{i=1}^{n} (RMTA_i * V2_i) - \sum_{i=1}^{n} (V2_i * V3_i) * \sum_{i=1}^{n} (RMTA_i * V3_i)}{DTRM}$$

and

$$WYRM = \frac{\sum_{i=1}^{n} (V2_i * V3_i) * \sum_{i=1}^{n} (RMTA_i * V2_i) - \sum_{i=1}^{n} (V2_i * V2_i) * \sum_{i=1}^{n} (RMTA_i * V3_i)}{DTRM}$$

If $|DTPM| > DETM$,

$$WZPM = \frac{\sum_{i=1}^{n} (V3_i * V3_i) * \sum_{i=1}^{n} (PMTA_i * V1_i) - \sum_{i=1}^{n} (V1_i * V3_i) * \sum_{i=1}^{n} (PMTA_i * V3_i)}{DTPM}$$

and

$$WXPM = \frac{\sum_{i=1}^{n} (V1_i * V1_i) * \sum_{i=1}^{n} (PMTA_i * V3_i) - \sum_{i=1}^{n} (V1_i * V3_i) * \sum_{i=1}^{n} (PMTA_i * V1_i)}{DTPM}$$

If $|DTYM| < DETM$

$$WXYM = \frac{\sum_{i=1}^{n} (V1_i * V1_i) * \sum_{i=1}^{n} (YMTA_i * V2_i) - \sum_{i=1}^{n} (V2_i * V1_i) * \sum_{i=1}^{n} (YMTA_i * V1_i)}{DTYM}$$

and

$$WYYM = \frac{\sum_{i=1}^{n} (V2_i * V2_i) * \sum_{i=1}^{n} (YMTA_i * V1_i) - \sum_{i=1}^{n} (V2_i * V1_i) * \sum_{i=1}^{n} (YMTA_i * V2_i)}{DTYM}$$

If $|DTRM| < DETM$, $WZRM = 0$ and $WYRM = 0$

If $|DTPM| < DETM$, $WZPM = 0$ and $WXPM = 0$

If $|DTYM| < DETM$, $WXYM = 0$ and $WYYM = 0$

If $|DTRM| < DETM$ and $\begin{cases} |DTPM| > DETM, & WZRM = WZPM \\ |DTYM| > DETM, & WYRM = WYYM \end{cases}$

If $|DTPM| < DETM$ and $\begin{cases} |DTYM| > DETM, & WXPM = WXYM \\ |DTRM| > DETM, & WZPM = WZRM \end{cases}$

If $|DTYM| < DETM$ and $\begin{cases} |DTRM| > DETM, & WYYM = WYRM \\ |DTPM| > DETM, & WXYM = WXPM \end{cases}$

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The weight tare moment arms can then be calculated (for reference purposes only) as follows

$$YRM = \frac{WYRM}{WNF}$$

$$ZRM = \frac{WZRM}{WSF}$$

$$XPM = \frac{WXPM}{WNF}$$

$$ZPM = \frac{WZPM}{WAF}$$

$$XYM = \frac{WXYM}{WSF}$$

$$YYM = \frac{WYYM}{WAF}$$

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RTAT computes the weight tare factors based upon correct balance components, which in turn are based upon assumed initial loads equal to the wind-off zero loads. The newly computed weight tare factors are then used to recompute the initial loads, which are then compared to the original initial loads. If the new initial loads are sufficiently close to the old initial loads, they are assumed to have converged, and the tare computations are accepted. If the new initial loads are significantly different, the old initial loads are replaced with the new initial loads, which are then used to recompute correct balance components to start another iteration. This process continues until the initial loads converge or for a maximum of five iterations. The accuracy required for each component is obtained from the balance calibration.

RTAT saves in a COMMON area the nine weight tare factors, the six initial loads, and the wind-off zero attitude.

Correction for Weight Tares

RTAT obtains the nine weight tare factors, the six initial loads, and the wind-off zero attitude from a COMMON area.

For the balance at any attitude $[R_{gb}]$, [FTARE] is computed from the previously given equations where:

$$[FTARE] = \begin{bmatrix} AFTA \\ SFTA \\ NFTA \\ RMTA \\ PMTA \\ YMTA \end{bmatrix}$$

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Let [FBAL] denote the earodynamic loads in the balance axis system where

$$[FBAL] = \begin{bmatrix} AFBA \\ SFBA \\ NFBA \\ RMBA \\ PMBA \\ YMBA \end{bmatrix}$$

The aerodynamic loads in the balance axis system are computed by subtracting the weight tares from the correct delta balance loads:

$$[FBAL] = [F] - [FTARE]$$

RTAT appends the following to the data base: V1, V2, V3, AFTA, SFTA, NFTA, RMTA, PMTA, YMTA, AFBA, SFBA, NFBA, RMBA, PMBA, YMBA.

Computation of Model Attitude

The gravity axis to balance axis transformation $[R_{gb}]$ has been fully developed. Similar transformation matrices from wind axis to gravity axis $[R_{wg}]$ and from balance axis to model axis $[R_{bm}]$ may be defined on the basis of specified input rotation schemes.

The wind to gravity matrix $[R_{wg}]$ describes the tunnel flow angularity and is defined as an upflow or pitch rotation of magnitude ALPU and a crossflow or yaw rotation of magnitude XFLO. As presently constituted $[R_{wg}]$ does not include a roll rotation term. $[R_{wg}]$ is built into RTAT.

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For the balance to model matrix $[R_{bm}]$, RTAT expects to find the Keyword NBM in the data base followed by the rotation scheme. If NBM is not found, RTAT assumes a single pitch rotation of zero degrees. The elements of the balance to model transformation are computed frcm NBM successive applications of the individual transforms.

The attitude of the model with respect to the wind can then be described by the transformation matrix $[R_{WM}]$ given by:

$$[R_{WM}] = [R_{bm}][R_{gb}][R_{wg}]$$

The model attitude $[R_{WM}]$ can also be summarized as a single roll rotation PHIW, followed by a single yaw rotation YAWW, followed by a single pitch rotation ALPW. That is:

$$[R_{WM}] = [R_y(\text{ALPW})][R_z(\text{YAWW})][R_x(\text{PHIW})] = [R_y(\alpha_w)][R_z(\psi_w)][R_x(\phi_w)]$$

Substituting the elementary transforms and carrying out the indicated multiplications yields:

$$[R_{WM}] = \begin{bmatrix} WM11 & WM12 & WM13 \\ WM21 & WM22 & WM23 \\ WM31 & WM32 & WM33 \end{bmatrix} =$$

$$\begin{bmatrix} \cos\alpha_w\cos\psi_w & -\cos\alpha_w\sin\psi_w\cos\psi_w-\sin\alpha_w\sin\phi_w & \cos\alpha_w\sin\psi_w\sin\phi_w-\sin\alpha_w\cos\phi_w \\ \sin\psi_w & \cos\psi_w\cos\phi_w & -\cos\psi_w\sin\phi_w \\ \sin\alpha_w\cos\psi_w & -\sin\alpha_w\sin\psi_w\cos\phi_w+\cos\alpha_w\sin\phi_w & \sin\alpha_w\sin\psi_w\sin\phi_w+\cos\alpha_w\cos\phi_w \end{bmatrix}$$

Solving for YAWW, ALPW, and PHIW gives:

$$\text{PHIW} = -\arctan(\text{WM23}/\text{WM22}) + \phi_q$$

$$\text{YAWW} = \arcsin\ (\text{WM21})$$

$$\text{ALPW} = \arctan\ (\text{WM31}/\text{WM11}) + \alpha_q$$

under the following restrictions:

$$-\frac{\pi}{2} \leq \text{YAWW} \leq \frac{\pi}{2}$$

If WM22 > 0 and WM23 > 0, $\phi_q = 0$

If WM22 > 0 and WM23 <0, $\phi_q = 0$

If WM22 > 0 and WM23 = 0, PHIW = 0

If WM22 < 0 and WM23 > 0, $\phi_q = -180$

If WM22 < 0 and WM23 < 0, $\phi_q = 180$

If WM22 < 0 and WM23 = 0, PHIW = ±180

If WM22 = 0 and WM23 > 0, PHIW = -90

If WM22 = 0 and WM23 < 0, PHIW = 90

If WM22 = 0 and WM23 = 0, PHIW = 0

If WM11 > 0 and WM31 > 0, $\alpha_q = 0$

If WM11 > 0 and WM31 < 0, $\alpha_q = 0$

If WM11 > 0 and WM31 = 0, ALPW = 0

If WM11 < 0 and WM31 > 0, $\alpha_q = -180$

If WM11 < 0 and WM31 < 0, $\alpha_q = 180$

If WM11 < 0 and WM31 = 0, ALPW = ±180

If WM11 = 0 and WM31 > 0, ALPW = -90

If WM11 = 0 and WM31 < 0, ALPW = 90

If WM11 = 0 and WM31 = 0, ALPW = 0

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The anqle of sideslip is computed from the definition:

BETA = -YAWW

RTAT appends the following to the data base: WM11, WM21, WM31, WM12, WM33, WM32, WM13, WM23, WM33, PHIW, YAWW, ALPW, BETA.

Computation of Components in Model Axis System

RTAT obtains the correct balance axis components from the data base and makes use of the rotation matrix $[R_{bm}]$ to rotate them to the model axis system:

$$\begin{bmatrix} AFMA_1 \\ SFMA_1 \\ NFMA_1 \end{bmatrix} = [R_{bm}] \begin{bmatrix} AFBA \\ SFBA \\ NFBA \end{bmatrix}$$

$$\begin{bmatrix} -RMMA_1 \\ PMMA_1 \\ -YMMA_1 \end{bmatrix} = [R_{bm}] \begin{bmatrix} -RMBA \\ PMBA \\ -YMBA \end{bmatrix}$$

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The minus signs in the moment equation result from the inherent opposite-handedness of the conventional wind tunnel balance force and moment sign conventions. The subscripts on the model axis components are for clarity in the following presentation.

RTAT obtains the transfer distances XBAR, YBAR, and ZBAR from the data base. These describe the transfer from the balance moment center to the model moment reference center. The transfer equations are given by:

$$\begin{bmatrix} AFMA_2 \\ SFMA_2 \\ NFMA_2 \\ RMMA_2 \\ PMMA_2 \\ YMMA_2 \end{bmatrix} = \begin{bmatrix} AFMA_1 \\ SFMA_1 \\ NFMA_1 \\ RMMA_1 + NFMA_1 * YBAR - SFMA_1 * ZBAR \\ PMMA_1 - NFMA_1 * XBAR - AFMA_1 * ZBAR \\ YMMA_1 - SFMA_1 * XBAR - AFMA_1 * YBAR \end{bmatrix}$$

The subscripts on the model axis components are for clarity in the following presentation.

RTAT places AFMA, SFMA, NFMA, RMMA, PMMA, and YMMA in the data base.

APPENDIX G

Blockage and Jet Boundary Corrections

The blockage corrections are based on reference 4 and the jet boundary corrections are based on reference 5.

RTAT expects to find the Keyword BLK in the data base. BLK is a flag used to control the computation of both blockage and jet boundary corrections. A value of zero omits the corrections while a value of unity applies the corrections.

RTAT expects to find the following variables in the data base: KWI, KBI, J2, J3, P1, QINF, MACH, REYN, RHO, VINF, B, S, ALPW, BETA, AFMA, SFMA, NFMA.

For convenience, define the tunnel parameters uncorrected for blockage as:

PIPR = P1

QPR = QINF

MPR = MACH

RNPR = REYN

RHOPR = RHO

VPR = VINF

The apparent model axis forces are then computed:

ACAM = AFMA/(QPR*S)

ACYM = SFMA/(QPR*S)

ACNM = NFMA/(QPR*S)

These apparent force coefficients are then rotated to the stability and wind axes:

$$\begin{bmatrix} ACDS \\ ACYS \\ ACLS \end{bmatrix} = \left[R_y(-ALPW) \right] \begin{bmatrix} ACAM \\ ACYM \\ ACNM \end{bmatrix}$$

$$\begin{bmatrix} ACDW \\ ACYW \\ ACLW \end{bmatrix} = \left[R_z(BETA) \right] \begin{bmatrix} ACDS \\ ACYS \\ ACLS \end{bmatrix}$$

The corrected apparent drag coefficient is then calculated:

$$CDPR = ACDW - \frac{ACLW*ACLW*S}{\pi \left(\frac{B}{12}\right)^2}$$

The blockage correction factor is then

$$K = \frac{KWI + KBI}{(1 - XM2)^{3/2}} + \left(\frac{1 + 0.4*XM2}{1 - XM2}\right)*CDPR*KJ$$

where

$$XM2 = MPR*MPR$$

and

$$KJ = \frac{1}{4*C_{7x10}}$$

where C_{7x10} is the cross sectional area of the 7- by 10-foot high speed tunnel test section. (See reference 1.)

The tunnel parameters are then corrected for blockage:

P1 = PIPR*(1 - 1.4*XM2*K)

QINF = QPR*(1 + (2 - XM2)*K)

MACH = MPR*(1 + (L + 0.2*XM2)*K)

RHO = ROPR*(1 - XM2*K)

VINF = VPR*(1 + K)

REYN = RNPR*(1 +(1 - 0.7*XM2)*K)

The jet boundary corrections require the calculation of the apparent lift coefficient:

$$C = ACLW*(\frac{QPR}{Q})$$

The jet boundary correction factors for angle of attack and pitching moment are then:

DELA = CLC*J2

DELM = CLC*J3*QINF*S*CBAR

The angle of atta·k and model axis pitching moment are then corrected for jet boundary effect:

ALPW = ALPW + DELA

$PMMA_3 = PMMA_2 + DELM$

The subscripts on PMMA are for clarity in the following presentation.

RTAT updates the data base values of the following variables: P1, QINF, MACH, RHO, VINF, REYN, ALPW, PMMA. RTAT appends the following variables to the data base: PIPR, QPR, MPR, RNPR, ROPR, VPR, CDPR, CDC, DELA, DELM.

Base and Chamber Pressure Corrections

For base pressure, RTAT expects the Keyword NBAS to be available in the data base. If NBAS is not found or if it is less than 1, no base pressure computations will be performed. RTAT expects the base pressure specifications to follow NBAS in the data base. RTAT obtains from the data base the variables S, P1, QINF, and ALPW.

Letting PB_i denote the i^{th} base pressure, the individual pressure coefficients are computed as:

$$CPBi = \frac{PB_i - P1}{QINF}$$

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The forces and moments to be applied as a correction are computed as:

$$\begin{bmatrix} AFB \\ SFB \\ NFB \\ RMB \\ PMB \\ YMB \end{bmatrix} = \sum_i (PB_i - P1) \begin{bmatrix} -Area_{AF_i} \\ Area_{SF_i} \\ Area_{NF_i} \\ (Area*Arm)_{RM_i} \\ (Area*Arm)_{PM_i} \\ (Area*Arm)_{YM_i} \end{bmatrix}$$

where the summation i is over all base pressures for which the correction flag is turned on and where the column vector on the right side and the correction flag are obtained from the input specifications.

The forces and moments to be computed but not to be applied as a correction are given by:

$$\begin{bmatrix} XAFB \\ XSFB \\ XNFB \\ XRMB \\ XPMB \\ XYMB \end{bmatrix} = \sum_i (PB_i - P1) \begin{bmatrix} -Area_{AF_i} \\ Area_{SF_i} \\ Area_{NF_i} \\ (Area*Arm)_{RM_i} \\ (Area*Arm)_{PM_i} \\ (Area*Arm)_{YM_i} \end{bmatrix}$$

where the summation i is over all base pressures for which the correction flag is turned off and where the column vector on the right side and the correction flag are obtained from the input specification.

The axial force terms are also expressed in terms of axial and drag coefficients as:

CAB = AFB/(QINF*S)

CDB = CAB*COS(ALPW)

XCAB = XAFB/(QINF*S)

XCDB = XCAB*COS(ALPW)

RTAT appends the following to the data base: CPBi, AFB, SFB, NFB, RMB, PMB, YMB, XAFB, XSFB, XNFB, XRMB, XPMB, XYMB, CAB, CDB, XCAB, XCDB.

For chamber pressures, RTAT expects the Keyword NCBR to be available in the data base. If NCBR is not found, or if it is less than 1, no chamber pressure computations will be performed. RTAT expects the chamber pressure specifications to follow NCBR in the data base. RTAT obtains from the data base the variables S, P1, QINF, and ALPW.

Letting PC_i denote the i^{th} chamber pressure, the individual pressure coefficients are computed as:

$$CPCi = \frac{PC_i - P1}{QINF}$$

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The forces and moments to be applied as a correction are computed as:

$$\begin{bmatrix} AFCH \\ SFCH \\ HFCH \\ RMCH \\ PMCH \\ YMCH \end{bmatrix} = \sum_i (PC_i - P1) \begin{bmatrix} -Area_{AF_i} \\ Area_{SF_i} \\ Area_{NF_i} \\ (Area*Arm)_{RM_i} \\ (Area*Arm)_{PM_i} \\ (Area*Arm)_{YM_i} \end{bmatrix}$$

where the summation i is over all chamber pressures fcr which the correction flag is turned on and where the column vector on the right side and the correction flag are obtained from the input specifications.

The forces and moments to be computed but not to be applied as a correction are given by:

$$\begin{bmatrix} XAFC \\ XSFC \\ XNFC \\ XRMC \\ XPMC \\ XYMC \end{bmatrix} = \sum_i (PC_i - P1) \begin{bmatrix} -Area_{AF_i} \\ Area_{SF_i} \\ Area_{NF_i} \\ (Area*Arm)_{RM_i} \\ (Area*Arm)_{PM_i} \\ (Area*Arm)_{YMi} \end{bmatrix}$$

where the summation i is over all chamber pressures for which the correction flag is turned off and where the column vector on the right side and the correction flag are obtained from the input specifications.

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The axial force terms are also expressed in terms of axial and drag coefficients as:

CAC = AFC/(QINF*S)

CDC = CAC*COS(ALPW)

XCAC = XAFC/(QINF*S)

XCDC = CDC*COS(ALPW)

RTAT appends the following to the data base: CPCi, AFCH, SFCH, NFCH, RMCH, PMCH, YMCH, XAFC, XSFC, XNFC, XRMC, XPMC, XYMC, CAC, CDC, XCAC, XCDC.

Computation of Model, Stability, and Wind Axis Components

RTAT obtains the following from the data base: AFMA, SFMA, NFMA, RMMA, PMMA, YMMA, AFB, SFB, NFB, RMB, PMB, YMB, AFCH, SFCH, NFCH, RMCH, PMCH, YMCH, ALPW, BETA, QINF, S, B, CBAR.

The forces and moments are corrected for base and chamber pressures to give the final corrected model axis components:

$$\begin{bmatrix} AFMA \\ SFMA \\ NFMA \\ RMMA \\ PMMA \\ YMMA \end{bmatrix} = \begin{bmatrix} AFMA_2 \\ SFMA_2 \\ NFMA_2 \\ RMMA_2 \\ PMMA_3 \\ YMMA_2 \end{bmatrix} - \begin{bmatrix} AFB \\ SFB \\ NFB \\ RMB \\ PMB \\ YMB \end{bmatrix} - \begin{bmatrix} AFCH \\ SFCH \\ NFCH \\ RMCH \\ PMCH \\ YMCH \end{bmatrix}$$

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The stability axis components are obtained by rotating the model axis components through minus the angle of attack:

$$\begin{bmatrix} DRAG \\ SFSA \\ LIFT \end{bmatrix} = \left[R_y(-ALPW)\right] \begin{bmatrix} AFMA \\ SFMA \\ NFMA \end{bmatrix}$$

$$\begin{bmatrix} -RMSA \\ PMSA \\ -YMSA \end{bmatrix} = \left[R_y(-ALPW)\right] \begin{bmatrix} -RMMA \\ PMMA \\ -YMMA \end{bmatrix}$$

The wind axis components are obtained by rotating the stability axis components through the angle of sideslip:

$$\begin{bmatrix} AFWA \\ SFWA \\ NFWA \end{bmatrix} = \left[R_z(BETA)\right] \begin{bmatrix} DRAG \\ SFSA \\ LIFT \end{bmatrix}$$

$$\begin{bmatrix} -RMWA \\ PMWA \\ -YMWA \end{bmatrix} = \left[R_z(BETA)\right] \begin{bmatrix} -RMSA \\ PMSA \\ -YMSA \end{bmatrix}$$

APPENDIX G

Computation of Coefficients

Let [FMA], [FSA], and [FWA] denote the model, stability, and wind axis components:

$$[FMA] = \begin{bmatrix} AFMA \\ SFMA \\ NFMA \\ RMMA \\ PMMA \\ YMMA \end{bmatrix}$$

$$[FSA] = \begin{bmatrix} DRAG \\ SFSA \\ LIFT \\ RMSA \\ PMSA \\ YMSA \end{bmatrix}$$

$$[FWA] = \begin{bmatrix} AFWA \\ SFWA \\ NFWA \\ RMWA \\ PMWA \\ YMWA \end{bmatrix}$$

Define the 6 x 6 main diagonal matrix $[C]$ as:

$$[C] = \begin{bmatrix} \frac{1}{QINF*S} & & & & & \\ & \frac{1}{QINF*S} & & & & \\ & & \frac{1}{QINF*S} & & & \\ & & & \frac{1}{QINF*S*B} & & \\ & & & & \frac{1}{QINF*S*CBAR} & \\ & & & & & \frac{1}{QINF*S*B} \end{bmatrix}$$

where all of the elements off the main diagonal are zero.

Let $[CMA]$, $[CSA]$, and $[CWA]$ denote the model, stability, and wind axis coefficients:

$$[CMA] = \begin{bmatrix} CA \\ CY \\ CN \\ CRM \\ CM \\ CYM \end{bmatrix}$$

$$[CSA] = \begin{bmatrix} CD \\ CYS \\ CL \\ CRMS \\ CMS \\ CYMS \end{bmatrix}$$

$$[CWA] = \begin{bmatrix} CDW \\ CYW \\ CLW \\ CRMW \\ CMW \\ CYMW \end{bmatrix}$$

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The model, stability, and wind axis coefficients are then computed as:

$$[CMA] = [C][FMA]$$

$$[CSA] = [C][FSA]$$

$$[CWA] = [C][FWA]$$

The lift to drag ratio and lift squared are also computed as:

L/D = CL/CD

CLSQ = CL*CL

RTAT updates the data base vlaues of the following variables: AFMA, SFMA, NFMA, RMMA, PMMA, YMMA. RTAT appends the following variables to the data base: DRAG, SFSA, LIFT, RMSA, PMSA, YMSA, AFWA, SFWA, NFWA, RMWA, PMWA, YMWA, CA, CY, CN, CRM, CM, CYM, CD, CYS, CL, CRMS, CMS, CYMS, CDW, CYW, CLW, CRMW, CMW, CYMW, L/D, CLSQ.

APPENDIX G

Pressure Coefficient Arrays

RTAT expects the Keyword NCP to be available in the data base. If it is not found or if it is less than 1, no pressure coefficient arrays will be computed. RTAT obtains P1 and QINF from the data base.

Let P denote the name of the input pressure and C_p denote the name of the output pressure coefficient, then the pressure coefficient is computed as:

$$C_{p_i} = \frac{P_i - P1}{QINF}$$

where i goes from 1 to NSIZE which is obtained from the input specification. Note that NSIZE consecutive data items in the data base starting with P will be replaced by the corresponding C_p and thus P will not be available for further processing or output.

Pressure Ratio Arrays

RTAT expects the Keyword NRTO to be available in the data base. If it is not found or if it is less than 1, no pressure ratio arrays will be computed.

Let P denote the name of the input pressure and P_R denote the name of the output pressure ratio, then the pressure ratio is computed as:

$$P_{R_i} = \frac{P_i}{Scalar}$$

where i goes from 1 to NSIZE which is obtained from the input specification as is the name Scalar. Note that NSIZE data items will be appended to the data base.

Flowmeter Computations

RTAT expects the Keyword NFLO to be available in the data base. If NFLO is not found or is less than 1, no flowmeter computations will be performed. RTAT obtains the following variables from the data base: HI, TT, FPn, FDPn, and FTn where n is the flowmeter number.

RTAT contains complete tables of parameters for all of the venturi-type flowmeters available for use in the 7- by 10-foot high speed tunnel.

The flowmeter fluid viscosity is computed as

$$ZMUn = ((.1211*10^{-4}) + ((4/3)*10^{-3}*FP))*\left(\frac{FT_n}{529.47}\right)^{1.5}*\left(\frac{727.47}{FT_n + 198}\right)$$

The flowmeter diameter ratio is given by:

$$BETn = \frac{D1n}{D2n}$$

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The velocity of approach factor is computed as:

$$F_n = 1/\sqrt{1 - BET_n^4}$$

The throat static pressure is computed as:

$$FP2_n = FP_n - FDP_n$$

The static pressure ratio is computed as:

$$SPRn = FP2n/FPn$$

The flowmeter expansion factor is computed as:

$$Yn = YAAn + YABn*Rn$$

The flowmeter temperature is converted to degrees Fahrenheit by:

$$TF_n = FT_n - 459.688$$

The flowmeter supercompressibility factor is computed as:

C-4

$$B2 = .61113723*10^{-4}-.67725162*10^{-5}*TFn+.2912419*10^{-8}*TFn^{2}-.70789815*10^{-11}*TFn^{3}$$

$$B3 = -.15730387*10^{-7}+.10578106*10^{-3}*TFn-.14254673*10^{-11}*TFn+.81196439*10^{014}*TFn^{3}$$

$$B4 = -.76772236*10^{-12}-.12788883*10^{-2}*TFn+.59147764*10^{-15}*TFn^{2}-.36507332*10^{-17}*TFn^{3}$$

$$PF = FPn - 25.$$

$$SFMn = 1 + B2 * PF + B3 * PF^{2} + B4 * PF^{3}$$

The discharge coefficient, weight flow rate, and Reynolds number are iteratively computed as:

$$WPn = DCn*Fn* \sqrt{ABS(SFMn)} * A2n* Yn* 158.1948 * \sqrt{ABS(FPn*FDPn/FTn)}$$

$$RNn = (4 * WPn)/(ZMUn * 3.14159 * D2n/12)$$

$$DCn = \sum_{i=0}^{3} COEF_{i} **RNn^{i}$$

Normalized temperature is computed as:

$$THTn = TT/(459.688 + 59)$$

Normalized pressure is computed as:

$$LAMn = HI/2116.8$$

Normalized weight flow rate is computed as:

$$WPN = WPn * (\frac{\sqrt{THTn}}{LAMn})$$

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RTAT appends the following items to the data base: AMUn, D1n, D2n, BETn, Fn, FP2n, SPRn, Yn, TFn, SFMn, ASQn, DCn, WPn, RNn, THTn, LAMn, and WPNn where n is the flowmeter number.

Jet Exhaust Computations

When required, RTAT may be assembled with a special routine to permit real time calculation of and correction for jet exhaust effects. These computations are usually model dependent.

Unique Computations

When required, RTAT may be assembled with a special routine to perform computations unique to a particular model.

Extra Equations After Force

RTAT has the capability to execute extra equations after the force computations. The input specifications for this capability is given in APPENDIX D along with the algorithms.

Real Time Displays

RTAT expects the data item NDSP to be available in the data base. If NDSP is not found, or if it is less than 1, only ALPW and BETA will be displayed on the Automatic Angle Panels. The input specifications are given in APPENDIX C.

When a code number is entered into the thumbwheels beside one of the displays, the data value associated with that code number is displayed on that display. The displayed values are updated during every execution of RTAT. The exact timing depends on the OAP and RTAT input setup constants, but is normally approximately once every second. The displays cannot be updated while the RTAT task is executing a recorded data point, resulting in a delay of two to thirty seconds depending on the amount of printout and the type of plotting produced.

Line Printer Output

RTAT produces two different types of printout: point-by-point printout and run-by-run summary printout.

Point-By-Point Print

RTAT expects the data item NPG to be available in the data base. If NPG is not found, or if it is less than 1, no point-by-point line printer output will be produced.

Point-by-point printout is produced for every recorded data point.

Run-By-Run Summary Print

RTAT expects the data item NGP to be available in the data base. If NGP is not found, or if it is less than 1, no run summary line printer output will be produced.

The actual run summary printout is produced only on request in response to the thumbwheel entry of a specific data identification code.

The data requested on the specifications is saved on a point-by-point basis on files on the disk. The print segment will give a warning message before overflow of these files occurs.

Plot Output

RTAT produces two different types of plots: point-by-point plots and summary plots.

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Point-By-Point Plots

RTAT expects the data item NPLT to be available in the data base. If NPLT is not found, or if it is less than 1, no plots will be produced.

If the NPLT specifications are used to plot pressure arrays, then RTAT expects the data item MPLT to be available in the data base. If MPLT is not found, or if it is less than 1, no additional plots will be produced. These specifications may only be used to plot additional pressure arrays.

For pressure arrays, a complete plot is generated for each test point. For force data a complete plot is generated for each run. Hard copies are automatically generated as appropriate.

Summary Plots

RTAT expects the data item SPLT to be available in the data base. If SPLT is not found, or if it is less than 1, no summary plots will be generated.

RTAT Output Tape

RTAT will write an answer tape in standard interface format. This tape may be used for subsequent processing.

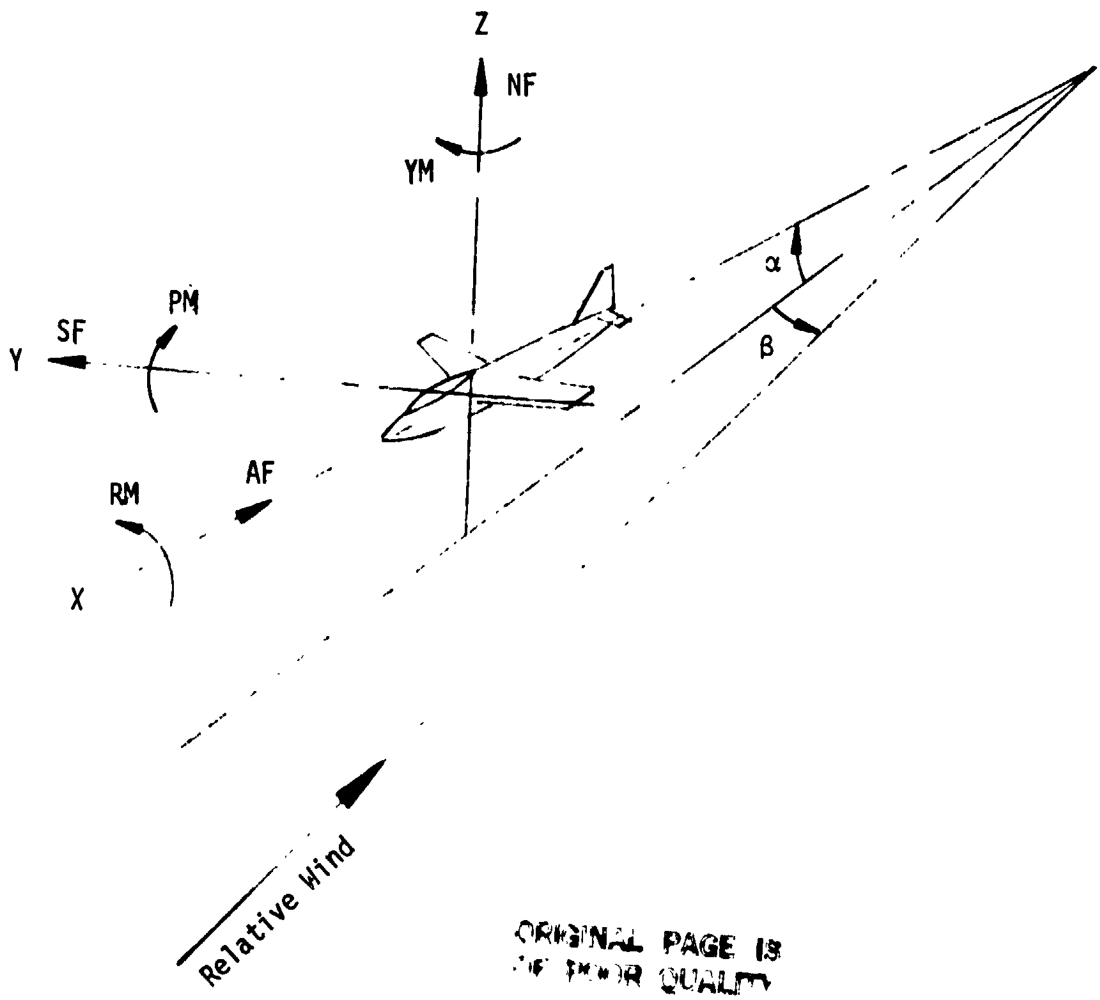

Figure G-1.- Force and moment model axes with positive directions shown.

APPENDIX H

RTAT OPERATING PROCEDURES

Initial OAP Startup

Before starting RTAT, it is necessary for the current version of the 7- by 10-foot tunnel operating system to be running on the Sigma 3 computer. An appropriately prepared setup deck should then be loaded into the card reader. The OAP will start execution and wait for an Enter on the System Control Panel. The following sequence of operations must then be performed:

(a) On the System Control Panel, set the Data Ident thumbwheels to 00. Select the ON position for Select Options, List, Tape, Request, Free. Verify the proper setup of the other control panels.

(b) Press the Enter button on the System Control Panel. OAP will read the OAP setup cards and perform a consistency check. OAP will report any inconsistencies and request that they be resolved before proceeding further.

(c) Select the ON position for Calibrate on the System Control Panel and press the Enter Button. OAP will perform an analog system calibration and report the results.

(d) Select the ON position for Dau Data on the System Control Panel and press the Enter button. Press the Ready/Cycling button on the System Control Panel. OAP will record a zero data point and trigger the RTAT tasks.

APPENDIX H

Initial RTAT Startup

The data ident codes currently recognized by RTAT are presented in Figure H-1.

After OAP triggers the RTAT tasks, perform the following steps:

(a) On the System Control Panel, set the Data Ident thumbwheels to 09 and pressure the Enter button. RTAT will read the RTAT setup cards and perform a names record execution and report the results.

(b) Set the Data Ident thumbwheels to 00 and press the Enter button. Press the Ready/Cycling button. OAP will record a zero data point and RTAT will compute the zero data point.

RTAT Setup Change

Whenever it is desired, a new RTAT setup may be performed. The recommended method of accomplishing this is to read in an entire setup deck as follows:

(a) Place the new RTAT setup deck in the card reader.

(b) On the System Control Panel, set the Data Ident thumbwheels to 09 and press the Enter button. RTAT will read the RTAT setup cards and perform a names record generation execution and report the results.

If the only changes required are the addition of new D-type constants or changes to the values of C-type constants, it is possible to input only the new cards and not an entire setup deck. This may be accomplished by using a Data Ident thumbwheel setting of 29 in step (b) above. This method <u>is not recommended</u> for anyone without a thorough knowledge of the data base because it may lead to subtle errors in the interpretation of the new setup by RTAT and may invalidate the real time data reduction.

APPENDIX H

Responding to a Change in OAP Setup

Certain changes in the OAP setup require a response from RTAT in the form of a new names record execution without the need for a change in the RTAT setup deck. This will occur, for example, if the length of the OAP write-scan table is changed by adding or deleting channels or by turning the scanivalves on or off. (Note: If the scanivalves are turned on or off, RTAT requires that the OAP PVID bits also be turned on or off correspondingly in order for RTAT to correctly interpret the status of OAP. That is, with the scanivalves turned off but the PVID bits turned on, RTAT will not generate a name for the analog channels indicated by the PVID bits.)

RTAT will not automatically respond to a change on OAP setup, the operator must so direct RTAT. This is accomplished by the following step:

(a) On the System Control Panel, set the Data Ident thumbwheels to 19 and press the Enter button. RTAT will perform a names record generation execution and report the results.

This procedure may also be used when there is no change in OAP setup in order to obtain an additional names record execution report.

Wind Off Zero Records

A wind off zero point is recorded as follows:

(a) On the System Control Panel, select the ON position of Dau Data, set the Data Ident thumbwheels to 00 and press the Enter button.

(b) Press the Ready/Cycling button. OAP will record a zero data point and RTAT will compute a wind off zero data point.

APPENDIX H

Weight Tare Records

A wind off zero must be recorded prior to recording any weight tare data. At least two weight tare points must be recorded at attitudes sufficiently different from each other and from the wind-off zero attitude to allow proper angle resolution during the weight tare factor computations. A normal weight tare run may include data recorded at a half-dozen different attitudes.

A weight tare point is recorded as follows:

(a) On the System Control Panel, select the ON position of Dau Data, set the Data Ident thumbwheels to 0.1 and press the Enter button.

(b) Press the Ready/Cycling button for each weight tare point to be recorded. OAP will record a data point and RTAT will compute a weight tare point and save it on a special disk file for use in weight tare factor computations.

Weight Tare Factor Computations

After a set of weight tare points have been recorded, the operator must direct RTAT to compute the weight tare factors. This is accomplished as follows:

(a) On the System Control Panel, set the Data Ident thumbwheels to 21 and press the Enter button. RTAT will read the weight tare data it saved on the disk, compute the weight tare factors, generate a report, and save the weight tare factors in a COMMON area for later use in the computations.

APPENDIX H

Wind-On Data Records

A wind-off zero record must be recorded prior to recording any wind-on data. If weight tare corrections are to be applied, the weight tare factors must be available to RTAT.

Wind-on data are recorded as follows:

(a) On the System Control Panel, select the ON position for Dau Data, set the Data Ident thumbwheels to 04, and press the Enter button.

(b) Press the Ready/Cycling button for each wind-on data point to be recorded. OAP will record a data point and RTAT will compute the wind on data point.

Calibration Data Records

Calibration data are recorded as follows:

(a) On the System Control Panel, select the ON position for Dau Data, set the Data Ident thumbwheels to 08, and press the Enter button.

(b) Press the Ready/Cycling button for each calibration data point to be recorded. OAP will record a data point and RTAT will compute a calibration point and save it on a special disk file for use in an interactive calibration workup session.

Interactive Calibration Computations

After a set of calibration points have been recorded, the operator must direct RTAT to workup the calibration constants. This is accomplished as follows:

(a) On the System Control Panel, select the ON position for Dau Data, set the Data Ident thumbwheels to 28, and press the Enter button. RTAT will enter an interactive mode and request inputs from the operator on the interactive device. The interactive commands are described in APPENDIX E.

APPENDIX H

Data Base Checkpoint Dumps

RTAT has the capability to generate a report on the complete contents of the data base at several points in the calculation sequence. This capability exists for any Data Ident having 0 for its left digit and is accomplished by changing that left digit to a 1.

Summary Output Generation

RTAT has the capability to save certain information on a special disk file. The operator must direct RTAT to process this summary file. This is accomplished as follows:

(a) On the System Control Panel, set the Data Ident thumbwheels to 24 and press the Enter button. RTAT will read the summary data from the special disk file, generate a summary report, and generate summary plots.

Pressurized Zero Data Records

A wind-off zero point must be recorded before a pressurized zero is recorded. For powered model testing, a pressurized wind-off zero is accomplished as follows after pressurization:

(a) On the System Control Panel, select the ON position for Dau Data, set the Data Ident thumbwheels to 05, and press the Enter button.

(b) Press the Ready/Cycling button for each pressurized wind-off zero to be recorded. OAP will record a data point and RTAT will compute the pressurized data point as a data point and not a zero point (which is what is desired) and generate a report.

APPENDIX H

Wind-On Powered Data Records

For powered model testing, powered wind on data are recorded as follows:

(a) On the System Control Panel, select the ON position for Dau Data, set the Data Ident thumbwheels to 06, and press the Enter button.

(b) Press the Ready/Cycling button for each powered data point to be recorded. OAP will record a data point and RTAT will compute a powered data point and generate a report.

Static Powered Data Records

For powered models, static powered data are recorded as follows:

(a) On the System Control Panel, select the ON position for Dau Data, set the Data Ident thumbwheels to 07, and press the Enter button.

(b) Press the Ready/Cycling button for each static powered data point to be recorded. OAP will record a data point.

Note that RTAT does not currently support static powered data.

Interactive Static Powered Data Computations

After a set of static powered calibration points have been recorded, the operator must direct RTAT to workup the calibration constants. This is accomplished as follows:

(a) On the System Control Panel, select the ON position for Dau Data, set the Data Ident thumbwheels to 27, and press the Enter button.

Note that RTAT does not currently support interactive workup of static powered calibration data.

APPENDIX H

System Calibrate Computation

When OAP performs an analog system calibration, it writes the system calibrate information on a special disk file. Additional processing by RTAT is required before RTAT can use the system calibrate data. This is accomplished as follows:

(a) On the System Control Panel, select the ON position for Dau Data, set the Data Ident thumbwheels to 40, and press the Enter button. RTAT will read the OAP system calibration data, process it, generate a report, and save it in a form which will enable RTAT to convert from uncorrected counts to corrected millivolts.

Link to Central Computer Complex

RTAT has the capability to save its inputs and results as a SIF on a magnetic tape. The SIF inputs may be stripped out of that SIF tape and sent over the data link to the Central Computer Complex. The operator must direct RTAT to submit a job to the data link. This is accomplished as follows:

(a) On the System Control Panel, select the ON position for DAU DATA, set the Data Ident thumbwheels to 50, and press the ENTER button. RTAT will write end of file marks on the SIF tape, rewind it, read the input data from it, and leave the SIF tape positioned to continue writing on it. RTAT will send over the data link a batch job consisting of a standard set of control cards with the input data as a SIF. This set of control cards will convert the Sigma 3 core image SIF to a Control Data core image SIF and save it on the Central Computer Complex with a unique file name. Normal Central Computer Complex jobs may then be submitted to access this data file and process it.

APPENDIX H

Link from Central Computer Complex

The Data Ident thumbwheel setting of 60 has been reserved for use in conjunction with the implementation of the data link from the Central Computer Complex to the Sigma 3.

Skip RTAT Idle Loop

It may sometimes be desirable to direct RTAT to cease its idle loop calculations. This will not only remove a heavy computational load on the Sigma 3 but may permit OAP setup changes to be made without worrying about their impact on the RTAT idle loop. This may be accomplished in the following way.

(a) On the System Control Panel, select the ON position for Dau Data, set the Data Ident thumbwheels to 90, and press the Enter button. RTAT will skip all execution including the idle loop. RTAT will continue to check for new Data Ident values which would require execution to begin again.

RTAT Error Messages

RTAT issues error and warning messages when it detects a problem in executing the requested function. The error messages appear on the typewriter and the warning messages appear on the line printer. A list of these messages along with the indicated problem is presented below:

"NEED NEW RTAT SETUP."- This message appears if RTAT attempts to execute without having received an input setup deck.

"DATA ID xx INVALID."- RTAT does not recognize data ident xx. It will not attempt to execute unless it recognizes the data identification code.

"AVGREC ERROR nnnnn" or "DIGICO ERROR nnnnn."- These messages appear if RTAT was returned error code nnnnn by the designated OAP support library routine. Refer to the documentation of the appropriate routine for the Precise error encountered. If either of these messages appear repeatedly, it is likely that the data base has been clobbered, although it is possible that an OAP or hardware malfunction has occurred. It is necessary to re-boot the RBM system and restart the OAP and the RTAT from scratch to recover from a clobbered data base. This should be done when the original problem which clobbered the data base has been corrected.

"NO SV NAME FOR CH nn."- This message appears if there is no entry in the OAP channel name table for scanivalve channel nn. RTAT uses the first two characters of the OAP name to generate the valve name portion of the port reading names. An unnamed scanivalve channel is ignored by RTAT.

"NO INTERACTIONS."- This message appears when RTAT is asked to compute weight tare factors without a balance interaction deck in the setup constants.

The warning messages which appear on the line printer are self-explanatory.

System Shutdown

When all of the data have been obtained, the shutdown of OAP and RTAT is accomplished as follows:

(a) Perform an OAP analog system calibration

(b) Perform an RTAT system calibrate computation

(c) To close out the OAP raw data tape: on the System Control Panel, select the ON position for EOT, and press the Enter button. Repeat this step three to six times.

(d) To close out the RTAT output tape: on the System Control Panel, set the Data Ident thumbwheels to 30 and press the Enter button, set the Data Ident thumbwheels to 31 and press the Enter button. Repeat this step.

(e) Rewind the data tapes, remove them from the tape drives, remove the write permit rings, and verify that the tapes are labelled correctly.

(f) Press the Copy button on the graphics terminal hard copy unit to obtain a copy of the last plot.

(g) Remove the output from the line printer.

(h) Power down the Sigma 3 and the graphics terminal. The Data Acquisition Unit power must be left on.

SIFT XKEY	WIND	POWER	FUNCTION	NORMAL ID	EXTRA ID	SPECIAL ID	EXPLANATION
ZERO	OFF	OFF	ZERO	00	10		
TARE	OFF	OFF	WEIGHT TARE	01	11	21&	COMPUTE TARES
DATA	ON	OFF	DATA	04	14	24&	PRINT RUN SUMMARY
POWZ	OFF	OFF	PRESSURIZED ZERO	05	15		
POWD	ON	ON	POWERED DATA	06	16		
POWS	OFF	ON	STATIC DATA	07	17	27&	COMPUTE STATIC DATA
CAL	OFF	OFF	CALIBRATION	08	18	28&	INTERACTIVE CALIBRATION
NAME	OFF	OFF	SETUP	09& NEW	19& NAMEGEN	29& UPDATE	
EOF	OFF	OFF	ENDFILE SIFT	30&	31&		
	OFF	OFF	SYSTEM CAL	40&			COMPUTE SYSTEM CAL
	OFF	OFF	LINK TO ACD	50&			
	OFF	OFF	LINK FROM ACD	60&			
	OFF	OFF	SKIP IDLE LOOP	90&			
	OFF	OFF	ROLLIN OAP	97&			
	OFF	OFF	ROLLOUT OAP	98&			

& INDICATES ENTER ID ONLY

Figure H-1.- Data identification codes.

APPENDIX I

RTAT MANUAL CHECKPOINT GUIDELINES

In order to verify that RTAT is correctly computing the data, it is necessary to manually go through the calculations for a checkpoint. To assist in verifying intermediate calculations, it is recommended that a data base checkpoint be recorded for a wind off zero and for a wind on data point. Using these two points, a manual calculation should be made which starts with all of the input and computes all of the output. The algorithms which RTAT uses have already been discussed in sufficient detail to permit this manual calculation. However, the manual calculation is by no means trivial.

It is the purpose of this section to outline some of the steps in the calculation for the case of a model with a single balance at angle of attack.

(a) For the wind off zero, use the engineering unit equations to calculate initial loads

$$[F_o]$$

(b) For the wind on data, use the engineering unit equations to calculate uncorrected delta loads

$$[FU]$$

(c) For simplicity, assume second order balance interactions are negligible to calculate correct delta loads

$$[F]$$

(d) Calculate correct total loads

[FT]

(e) Use the engineering unit equations to calculate indicated attitude

ϕ, θ, ψ

(f) Calculate sting bending angles

ϕ_s, α_s, ψ_s

(g) Calculate balance attitude with respect to gravity

ϕ_g, α_g, ψ_g

(h) Calculate model attitude with respect to wind

$\phi_w, \alpha_w, \psi_w, \beta$

(i) Calculate weight tares

[FTARE]

(j) Calculate aerodynamic loads on balance

[FBAL]

(k) Calculate uncorrected tunnel parameters

(l) Correct tunnel parameters for blockage and jet boundary

(m) Calculate base and chamber pressures and corrections

(n) Calculate model axis coefficients

[CMA]

(o) Calculate stability axis coefficients

[CSA]

(p) In order to check that second order interactions have been correctly applied, it is convenient to assume that the components are correct and verify the uncorrected components. This eliminates the iterative calculation required if the uncorrected components are assumed and the components are verified. This procedure assumes that $[F]$ and $[F_o]$ as computed by RTAT are correct and then proceeds as follows:

$$[FT] = [F] + [F_o]$$

$$[F2T] = [FT][FT]^{Transpose}$$

$$[FUT] = [C1][FT] + [C2][F2T]$$

$$[F2_o] = [F_o][F_o]^{Transpose}$$

$$[FU_o] = [C1][F_o] + [C2][F2_o]$$

$$[FU] = [FUT] - [FU_o]$$

The second order interactions have been correctly applied by RTAT if [FU] computed by this procedure agrees with the [FU] used by RTAT within the accuracy specified.

(q) The calculation of the angles using the Euler rotations presents a tedious manual calculation. An efficient manual algorithm is presented below. This algorithm consists of an initialization phase, a computation loop which is repeated for each rotation in sequence, and a termination phase.

Initialization

RV(1) = 1

RV(2) = 0

RV(3) = 0

RV(4) = 0

RV(5) = 1

RV(6) = 0

RV(7) = 0

RV(8) = 0

RV(9) = 1

APPENDIX I

Computation Loop

Let A = rotation angle in degrees

If A is a yaw rotation, let

N1 = 1

N2 = 2

If A is a pitch rotation, let

N1 = 1

N2 = 3

If A is a roll rotation, let

N1 = 2

N2 = 3

Now compute

```
T = RV(N1)*COS(A) - RV(N2)*SIN(A)
RV(N2) = RV(N1)*SIN(A) + RV(N2)*COS(A)
RV(N1) = T
N1 = N1 + 3
N2 = N2 + 3
T = RV(N1)*COS(A) - RV(N2)*SIN(A)
RV(N2) + RV(N1)*SIN(A) + RV(N2)*COS(A)
RV(N1) = T
N1 = N1 + 3
N2 = N2 + 3
T = RV(N1)*COS(A) - RV(N2)*SIN(a)
RV(N2) = RV(N1)*SIN(A) + RV(N2)*COS(A)
```

Repeat this computation loop for each rotation angle in sequence.

Termination

The resultant roll, yaw, and pitch angles, exclusive of quadrant determination, are given by

$$\phi = \arctan\left(\frac{-RV(8)}{RV(5)}\right)$$

$$\psi = - \arcsin\ (-RV(2))$$

$$\theta = \arctan\left(\frac{RV(3)}{RV(1)}\right)$$

BIBLIOGRAPHY

1. Fox, Charles H., Jr.; and Huffman, Jarrett K.: Calibration and Test Capabilities of the Langley 7- by 10-Foot High Speed Tunnel, NASA TM X-74027, 1977.

2. Ames Research Staff: Equations, Tables, and Charts for Compressible Flow, NACA Report 1135, 1953.

3. Smith, David L.: An Efficient Algorithm Using Matrix Methods to Solve Wind-Tunnel Force-Balance Equations. NASA TN D-6860, 1972.

4. Herriot, John G.: Blockage Corrections for Three-Dimensional-Flow Closed-Throat Wind Tunnels, with Consideration of the Effect of Compressibility. NACA Report 995, 1950.

5. Gillis, Clarence L.; Polhamus, Edward C.; and Gray, Joseph L., Jr.: Charts for Determining Jet-Boundary Corrections for Complete Models in 7- by 10-Foot Closed Rectangular Wind Tunnels, NACA WR-L-123, 1945.